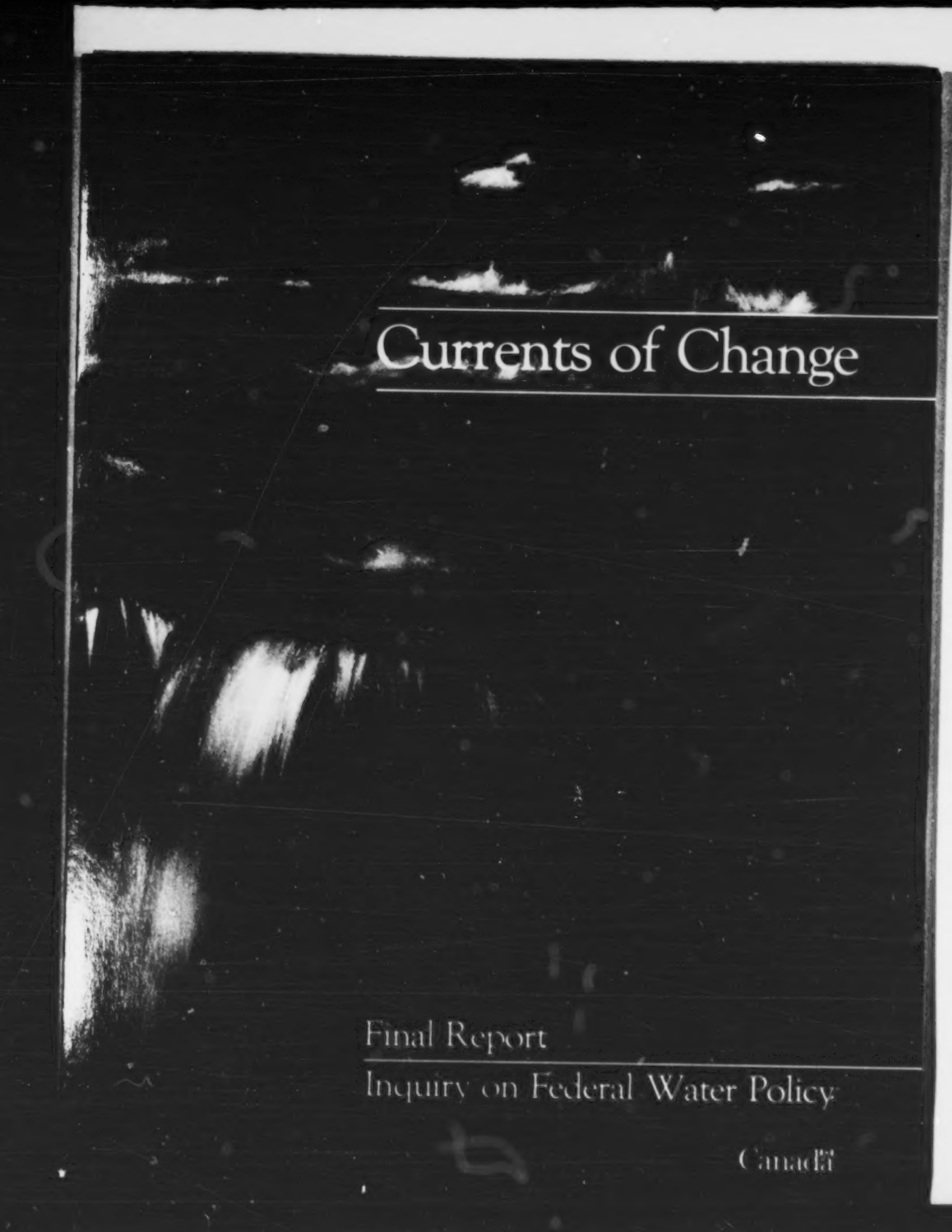

Currents of Change

Final Report

Inquiry on Federal Water Policy

Canada

Currents of Change

Final Report
Inquiry on Federal Water Policy

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September 1985

Canada

Inquiry on Federal Water Policy
Ottawa, Canada
K1A 1C7

Enquête sur la politique fédérale relative aux eaux
Ottawa, Canada
K1A 1C7

The Honourable Tom McMillan
Minister of the Environment

Dear Sir:

In January 1984, under the authority of the Canada Water Act (s.26) the then Minister of the Environment appointed us as an advisory committee to inquire into and make recommendations concerning a wide range of problems relating to the Government of Canada's water policy.

Our inquiry has been completed, and we are pleased to submit our report herewith.

Françoise Bertrand

James W. MacLaren

Peter H. Pearse (Chairman)

Ottawa, Ontario

September, 1985

Canada

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Foreword

The Inquiry on Federal Water Policy was established in January 1984, in response to a growing environmental consciousness and concern about the management of Canada's freshwater resources. Water is a special resource demanding visionary policies for its management. The purpose of this inquiry has been to advance this cause.

Our terms of reference asked us to assess the adequacy of federal water policy and the capacity of our institutions to respond to changing circumstances. They specifically requested us to consider the nature of emerging issues, the state of the resource, future requirements for water, interjurisdictional dimensions, and scientific and research expertise. They also directed us to seek the views of Canadian citizens.

Accordingly, we undertook a program of extensive consultation, public hearings, research and publication.

In the fall of 1984, we heard 201 presentations at our public hearings in seventeen locations across Canada, and have received over 300 written submissions from individuals and organizations. We also consulted frequently with provincial and territorial officials and many federal agencies to ensure that we considered a broad range of facts, viewpoints and advice.

In addition to these consultations, the inquiry commissioned studies and research projects on special problems. These studies are listed in this report's appendices.

The inquiry released publications associated with various phases of its work. To focus participation in our public hearings, we published, early in 1984, *Water Is A Mainstream Issue*, which set out our initial impressions of the issues and questions. In April 1985, following the public hearings, we released *Hearing About Water*, which synthesized the perceived problems, issues and solutions. We also published the research studies undertaken for the inquiry as they became available.

This final report results from activities designed not only to respond to our terms of reference, but also to promote understanding and to heighten awareness of the problems and opportunities in water management.

We cannot document, in this report, all the advice we have received. But we have tried to take account of it in reaching our conclusions and recommendations.

To the extent we succeed in initiating more effective water policy, we owe much to those who gave us the benefit of their experience and knowledge. Those who took the time to prepare submissions provided us with more information about water management in Canada than has ever before been assembled. We owe much of our understanding about the importance of water to these discussions. However, we accept full responsibility for the content of the report.

It is not possible for us to adequately recognize all those who assisted in this Inquiry. However, we want to acknowledge the help provided by governmental officials in the provinces and territories, and within many federal departments. We imposed on them heavy demands for information and assistance. Our heaviest demands were on senior officials of Environment Canada, who gave us continuing support and encouragement. A considerable number of experts in water management contributed to our investigations; much of their work is reflected in our research reports. Others helped us in less formal ways, and we want to acknowledge, especially the advice and assistance we received from Tony Hodge, Glynnis Horel, David Percy, John Stone and Andrew Thompson.

We must also recognize the support we received from our staff, especially Frank Quinn, Jan Glyde, Bernard Madé, John McHale, Ginette Dean, Josée Beaumier and Lise Saucier.

We are especially indebted to Elizabeth Dowdeswell who, as our Executive Director, organized our activities and devoted her impressive talents to the success of this inquiry. Our ability to conduct a thorough and efficient investigation owes a great deal to her and her dedicated staff.

A public inquiry such as this one is only the first step in reforming governmental policy. The next steps require determination and action on the part of the government itself. We are confident that all those who participated in this inquiry join us in urging the government to demonstrate leadership in the conservation and management of Canada's water resources so that future generations may enjoy its full benefits. One way or another, we are all caught in the currents of change.

Ottawa, September 1985

Part I

Water Resources and Policy Development

Chapter One

Principles and Perspectives

The connectedness of nature is more pervasive and the context for water policy more expansive than has previously been believed.

CANADIAN METEOROLOGICAL AND OCEANOGRAPHIC SOCIETY

As we conducted this inquiry the complexity of water policy development became apparent. We found it inextricably involved with environmental concerns, the economy, political relations, and social and heritage values. It also became clear that anxiety about our environment in general and about water in particular had become widespread.

The problems in water management are no longer local ones of water supply and pollution; but rather regional and even global problems arising from many sources: the collective effect of numerous small activities, projects of unprecedented scale, and increasing numbers of contaminants and toxic substances. As a result, we are facing growing conflicts among uses and users of water resources, which, until recently, we treated casually.

These problems challenge as never before our ability to design governmental policies capable of ensuring that our water resources will be protected.

Our present policies were designed to deal with simpler, more traditional problems; and federal policies in particular have evolved over the years in a piecemeal fashion, responding to problems and needs as they emerged. Policy development should, of course, respond to new events, problems and opportunities, but this is no longer enough. In the fast-moving technological environment of the late 20th century, policy making must anticipate as well as respond to problems, addressing them before they become crises.

For all these reasons, this inquiry is timely. The environmental consciousness of the 1960s has now matured into a broader, more balanced appreciation of the need to protect the integrity of natural systems as we use them for our economic advantage. Canadians realize that our long-term goals and social well-being depend on protecting our natural resources, and they are exerting pressure on the government to take appropriate actions.

In short, we are at a turning point in the way we think about our natural resources, in the way we plan and manage our water, and in the way citizens and governments interact.

Water

Water commands a unique place among our natural resources. It supports other resources such as fish and forests; it provides an important medium of transportation and energy production; it governs our settlement patterns; it is a major recreational resource; it inspires artistic and cultural expression; and, of course, it is essential for all life.

Nature has endowed Canada with more water than most other nations, and it has affected our agricultural, industrial, transportation and energy developments more profoundly than in other countries.

But even though our economy is oriented toward activities that depend heavily on water, its economic value tends to go unnoticed, partly because water is not priced and marketed like other resources. This also makes estimating its value difficult. However, it is thought to add between $8 billion and $23 billion per year to our national wealth — an enormous contribution.

Yet these estimates account for only those benefits that lend themselves to economic calculation. The more subtle recreational and aesthetic benefits we derive from our lakes and rivers, the appeal of natural water environments, and our national identification with water, defy measurement in conventional economic terms.

That Canadians do tend to identify themselves with a land laced with water is reflected in our artists' preoccupation with rivers, lakes and snow; in the references to water and activities associated with water in Canadian ballads and poetry; in the

prominence of pristine water in our tourist promotion material; and in the reference to Canada as a land where "lordly rivers flow" in our national anthem. The observation that water is important to Canadian society is not novel, but it provided the context for our inquiry and for this report.

To protect our most valuable liquid assets we must devote more attention to managing and conserving them. Historically, because water is abundant in most of Canada, we have used it casually and with little restraint. But the growth of population, industrialization, technology and urbanization have begun to impose demands that strain the capacity and quality of some natural water systems. We must, therefore, begin to manage water for what it is worth.

Basic Principles

We have been conscious of this being the first opportunity in Canadian history to thoroughly assess the federal government's policy toward freshwater resources. Such an opportunity cannot be expected to recur soon. Consequently, we have taken a broad, long-term view.

We attempt to articulate the scope of federal responsibilities, to establish principles on which federal policy and programs should be based, and to develop a coherent and rational framework for the federal presence in water management. We have attempted to propose recommendations that are socially acceptable, politically viable and economically feasible. Our ultimate objective is to provide for a federal water policy that will ensure Canadians sufficient, safe water to sustain their physical, economic and social well-being for all time.

Several principles provided the framework for this inquiry. Because they have shaped our recommendations we note them at the outset.

With respect to water management we believe that:

- The watershed is the natural and most appropriate unit for water management.
- Water management should accommodate the interdependence of multiple water and land uses within the watershed.
- Water management must recognize the continuity of the hydrologic cycle. Surface water, groundwater and the atmosphere must be considered as an integrated system.
- Water policy and management should aim at sustaining the natural health and productivity of water systems.
- Proposals for water development projects should take systematic account of economic and environmental risks and uncertainties.
- When major or irreversible alterations to water systems are contemplated, the intrinsic value of preserving natural flows and the hydrologic regime should be recognized.
- Because water is a valuable natural resource, users should be encouraged to recognize the value of the water they use and the associated costs of providing it.
- To ensure that the full spectrum of public values is considered in water management decisions, effective public participation must be sought.

Beyond these general principles, we believe the following should guide the federal government in determining and fulfilling its appropriate role in water management:

- Federal government activity in water management must be justifiable as a federal responsibility under the Constitution. The federal government must be sure that its activities have a clear mandate in statutes or federal-provincial agreements.
- Until native rights are finally settled, water resource management and projects should take careful account of the special interests of native people.
- To ensure effective and efficient water management in Canada, the federal government must reconcile its programs with those of provincial and territorial governments.
- The federal government should encourage individuals and corporations who use water to recognize the full social impact of their activities and to accept responsibility for using water wisely.
- The federal government's activities related to water management should be available to all Canadians equitably. At the same time, federal programs must be sensitive to different regional needs.
- The federal government's activities in water management should be undertaken in an effective, efficient and consistent manner. They should be designed and delivered with due regard for responsible resource use.
- To develop and implement sound water

management policies, the federal government must have superior technical and scientific knowledge.

We focus on the federal government's role in water policy and on strategies for fulfilling that role. But because environmental issues are not easily divided between federal and provincial governments, our analysis of federal policy and programs inevitably touches on the activities of its provincial counterparts. It has not been our intention to investigate provincial water policy or to advise provincial governments. Therefore, our recommendations are directed solely to the federal government.

The next chapter describes the historical context in which federal water policy has evolved.

Part II provides a picture of Canada's water resources, their abundance, quality and geographical distribution. The demands and pressures on the quality and supply of the resource clearly illustrate the need to review current policy.

Part III describes the constitutional responsibilities of the federal government and the legal framework it has adopted to meet its responsibilities in water management nationally and internationally. We assess the adequacy of this framework in light of emerging issues and recommend certain changes.

Part IV examines the complex issues of water management. Current policies and programs are reviewed and new approaches to management and conservation are proposed.

Part V discusses the unique importance of water resources in the northern territories and evaluates the resulting policies, programs and administrative structures.

Part VI examines the federal government's organizational structure for fulfilling its responsibilities in water management. The discussion focusses on the pivotal role of Environment Canada. We emphasize the importance of clearly understood and coordinated working relationships within the federal system and with provincial and territorial governments. We review as well the increasingly important provisions for public participation in decisions about the way natural resources are used and developed.

In the concluding chapter we take a retrospective view of our recommendations with reference to the principles with which we began.

Chapter Two

Evolution of Federal Water Policy

. . . water is not a resource like coal or wheat; it is much more a part of the landscape and of the people, and indeed of the Canadian essence.

W. LIEBAU

This chapter explores the historical context of the many laws, institutions and programs that make up federal water policy. Our purpose is not to pass judgement on the wisdom of past decisions, but to understand how we arrived where we are today and to decide whether we should continue along the same course.

Before Confederation

Most early peoples in North America were nomadic or seminomadic, and used the waterways extensively as transportation networks. They perfected open-water travel and portaging by developing the dugout and bark canoes and the kayak. Hunting and trapping, fishing and wild rice gathering were also focused on or along waterways. Native communities are still concentrated along Canada's major drainage courses, as well as on smaller lakes, rivers and estuaries.

For the Europeans as for the native people, lakes and rivers became the basis for an evolving communication and transportation network and for securing dominion over the northern half of the continent.

From the first decade of the 17th century, New France spread along the shores of the St. Lawrence River, the only means of communication within the colony and with the outside world. For these early settlers, the river also provided sustenance. Habitants were generally allowed to fish in the waters bordering their concessions without fear of seigneurial exactions. And tributary streams powered early timber and agricultural processing activities.

During the prolonged struggle for control of the New World, water routes to the interior had strategic importance for trade and territorial control. In the competition for furs, England granted a charter in 1670 to a "Company of Adventurers" to all territories drained by rivers flowing into Hudson Bay. This act engendered conflict with Quebec-based voyageurs and ultimately deterred British settlement in the western territories until Rupert's Land was sold to the Dominion after Confederation.

Britain was generally content to leave most of the northwest in the hands of the Hudson's Bay Company. The Palliser expedition, commissioned from London in the 1850s, was an exception to this benign neglect. But Captain Palliser's report on the prospects for inhabiting the southern portion of the prairies was discouraging because he considered it too arid for agriculture.

When traditional Baltic sources of timber were cut off by the Napoleonic blockade of 1806-15, Britain needed the forest reserves of her North American colonies. This fostered rapid timber exploitation in the Saint John, Saguenay and Ottawa valleys. Logs were floated and collected on water, which often necessitated small dam construction.

Navigation on larger watercourses often required canals and locks. Between 1815 and 1834 the Royal Engineers constructed canals to bypass the Lachine Rapids and to make navigable the Ottawa and Rideau rivers. These were considered safer than the St. Lawrence route, which was more vulnerable to attack in the event of renewed hostilities with the Americans. As these fears diminished, the canals were improved in an attempt to prevent trade from being diverted by the Erie Canal south of the border.

The 1840s experienced a great canal boom. This was financed by Imperial loans, but planned and implemented by commissioners of public works of the United Province of Canada, a predecessor to the federal Department of Public Works.

Establishing Federal Roles, 1867 — World War II

The *British North America Act* of 1867 (now the *Constitution Act*), did not mention

water. But it did allocate exclusive legislative jurisdiction over fisheries and navigation to the federal government, and jurisdiction over agriculture to federal and provincial governments. Treaty-making, extraprovincial trade and undertakings and criminal law also fell to the federal government, as did the powers to conduct census and to collect statistics. Later court decisions provided interpretations of these and other general powers, including their possible application to water resources. These are considered in a later chapter.

Provincial powers were based largely on property and civil rights and control over local works and undertakings. This meant that provinces could manage natural resources within their boundaries without restriction except in areas subject to federal legislative control.

For a period of several decades after Confederation, water-related policies were often incidental to other pursuits. Thus, in examining federal roles in water from 1867 to World War II, the activities of various government agencies need to be reviewed. (1)

Fisheries

The first *Fisheries Act*, which preceded Confederation by ten years, was administered by the Department of Marine and Fisheries. From that time, overfishing was the main concern. Consequently, in addition to enforcing regulations and issuing licences, fisheries officials became involved in fish replenishment programs, building hatcheries and salmon-rearing ponds. In 1892, a Fisheries Intelligence Bureau began collecting and distributing information by telegraph on fishing conditions across Canada.

Regulation of inland fisheries became one of the first examples of federal-provincial conflict in Canadian waters with three separate court cases being taken to the Privy Council in London between 1898 and 1920. Under its resolution, the federal government retained the right to regulate inland (nontidal) fisheries, but the provinces were granted administrative jurisdiction over them. In effect, the provinces could establish their own regulations as well as enforce the *Fisheries Act*. This confusing situation prevails today.

Different arrangements have been made with different provinces regarding fisheries administration. In British Columbia, for example, the federal government retains full control over salmon in inland waters, while in Quebec, the provincial government manages them.

Navigation

The Department of Public Works, created by federal legislation in 1867, was initially responsible for canals, lighthouses and harbours. In 1879, the responsibility for administering these facilities but not for designing or constructing them, was given to the Department of Marine and Fisheries and to the new Department of Railways and Canals (later Transport). The relationship among these three departments changed over the decades.

To facilitate the transport of logs, Public Works built many structures on smaller streams. It also built locks and fishways on larger navigable waterways, including St. Andrew's lock on the Red River (1900-1916) and storage dams in the French and Ottawa basins. The latter were part of the department's great dream of a Georgian Bay Ship Canal, a route for ocean shipping to reach the Great Lakes via the Ottawa River. The department also surveyed the Saskatchewan River early in the present century and improved navigation on the Mackenzie and Yukon rivers. However, it was the St. Lawrence, not the Ottawa River-Georgian Bay route, to which most attention was directed after World War I.

Agriculture

After acquiring Rupert's Land from the Hudson's Bay Company in 1870, the Dominion commissioned surveys to assess the agricultural potential of the prairies. The Macoun report predicted that only 5 percent of the prairies would be unsuitable for agriculture, contradicting an earlier survey that indicated the land was too arid. This was good news for the Dominion and the CPR, who were both interested in establishing a chain of settlements from coast to coast. The *Dominion Lands Act* was passed in 1872, authorizing homesteading in this region.

Neither the Department of the Interior nor the railway were prepared to acknowledge the need for irrigation in any part of the prairies during the 1880s because they feared that doing so would discourage immigration. Widespread droughts in the latter half of the decade, however, made this position untenable. Farmers lobbied for change and Interior officials thereafter

undertook the first surveys to determine what land would be suitable for irrigation.

Their efforts resulted in the *Northwest Irrigation Act*, passed in 1894. The Act established the concept of publicly administered irrigation districts, which were realized in the next century when private enterprise abandoned its unprofitable investments. Of even greater significance, the Act incorporated two principles of Canadian water law which were retained by subsequent provincial legislation and which allowed orderly development of western rivers: ownership of surface waters was vested in the Crown, and their use became subject to government licence. (2)

At the Dominion-Provincial Conference of 1927, the prairie provinces insisted on control of their natural resources. They even requested compensation for the material advantage the federal government had derived from these resources since 1870. Their first objective was achieved in the 1930 Natural Resource Transfer Agreements. Nevertheless, the federal government was forced to assume much of the provinces' indebtedness and provide relief during the depression and drought years of the 1930s. The Prairie Farm Rehabilitation Administration was established in 1935 to undertake programs in the drought and soil-drifting areas of the three provinces. An amendment in 1939 removed the original five-year limitation and permitted the Minister of Agriculture to enter into agreements with provinces, municipalities or persons for project development, operation and maintenance. The Prairie Farm Rehabilitation Administration immediately established a visible federal presence at the farm, community and regional level by participating in thousands of small dams and dugouts, community water supplies and later in major irrigation projects.

Surveys

Before 1904, various departments surveyed river flows, depths of lakes and harbours, dam sites and the like in response to their own particular navigation, irrigation and fisheries needs. After 1904, such surveys were assigned to a branch of the Department of the Interior; then in 1936, they were assigned to the new Department of Mines and Resources.

Water quality monitoring began in 1934. Curiously, the authors of a report that surveyed the "Industrial Waters of Canada" for the Department of Mines and Resources in 1942 seem to have anticipated the acid rain issue by at least three decades:

> Above large manufacturing areas the air is often laden with dust of all kinds, soot, silica, silicates, sulphates and carbonates, sulphuric and sulphurous acid. . . These are all adsorbed in the falling rain or snow, resulting in a very inferior water. . . Even in places where there is no factory pollution of the air, . . . the rain water shows appreciable amounts of dissolved and adsorbed matter. (3)

At the Dominion-Provincial Conference on Reconstruction in 1945, the federal government adopted a policy on the division of responsibilities with the provinces. In the water resources area, the federal government undertook responsibility for basic surveys and research on a national scale, general and basic census surveys relating to resource development and public investment, protection of regional watersheds (e.g. east slope of the Rockies), and the integrated development of interprovincial river systems.

Conservation

In 1909, the federal government established a Commission of Conservation in response to conservation movements in the United States and the success of the first Canadian forestry convention. The Commission's water studies focused primarily on hydroelectricity and the protection of municipal water supplies. The Commission was dissolved in 1920 on the grounds that its functions had already been assumed by other government agencies. Its main accomplishment was to provide a national forum for discussing resource issues and the need for cooperation between public and private sectors to avoid resource waste.

Boundary Waters

By the turn of the century a number of irritants concerning waters flowing along or across their common boundary had arisen between Canada and the United States. These included water levels control at Lake of the Woods, power developments on the St. Mary's and Niagara rivers in the Great Lakes basin, and conflicting plans for acquiring irrigation water from the St. Mary and Milk rivers of Alberta and Montana. Ad hoc investigations and meetings

in London and Washington proved cumbersome and unproductive.

In 1905, an International Waterways Commission with representatives from the two countries was established to provide advice on the Great Lakes-St. Lawrence system. The Commissioners recommended general principles to be followed in resolving disputes. The resulting Boundary Waters Treaty, signed by Great Britain and the United States in 1909, became a far-reaching document that, among other things, created the International Joint Commission with equal representation from both countries. It also provided for joint studies, established rules for approving works and uses, and prohibited transboundary pollution that would result in injury to health or property.

The Government of Canada was pleased with the Treaty because it referred to equality and focused on general principles, which gave some protection to the smaller and later-developing party in cases of conflict. Parliament passed the *International Boundary Waters Treaty Act*, which enabled the federal government to implement its responsibilities under the Treaty.

In its early years, the International Joint Commission failed to generate much action on the part of national governments regarding pollution and navigation in the Great Lakes-St. Lawrence basin. In its 1918 report, it presented evidence of seriously contaminated water in many locations along the boundary. But by adopting the newly developed practice of chlorinating municipal water supplies, governments avoided having to take further action.

A treaty for navigational improvements on the St. Lawrence River was recommended in 1921, but neither country was ready to proceed. Quebec at first opposed the project because of potential losses to the port of Montreal; and both Quebec and Ontario opposed federal involvement in electrical power developments, which would be part of the treaty scheme. Following an unsuccessful attempt to clarify jurisdiction on this matter in the Supreme Court, the federal government substantially conceded provincial claims to ownership and control of waters for power generation whether or not they were navigable.

Hydroelectricity generation expanded quickly in the early years of the 20th century, fostered by provincial governments, which saw immediate advantages in stimulating industrial growth. This led at first to indiscriminant development by private interests and, in the Niagara region, to contracts for selling power across the international boundary for periods of up to 99 years. Public concern about the export of a resource that might be needed by domestic industry — and in fact was needed during the first World War — led to federal legislation prohibiting long-term electricity exports, which stood for several decades. (4) Only close cooperation between Canada and the United States in their common war effort prevented power exports from becoming an issue in World War II. In fact, the United States, in a 1940 wartime note, agreed to allow Ontario Hydro to retain full power benefits at Niagara from the latter's diversion of flows into the Great Lakes system from Ogoki and Long Lac. These benefits were retained subsequently in the Niagara River Water Diversion Treaty.

Resource Developments, 1945-65

The tempo of federal interests in natural resource development quickened after World War II, sparking new institutions, cooperative programs, and several major water projects. At this time a federal water policy began to take shape, if only slowly.

Domestic Initiatives

Early water-related initiatives were primarily regional in character and included the following:

- The Maritime Marshlands Rehabilitation Administration was established in 1948 to construct or reconstruct dykes (aboideaux) and breakwaters, in cooperation with the Maritime provinces, to protect productive marsh areas from coastal flooding.
- The Eastern Rockies Forest Conservation Board, which was established in 1947, provided for joint forest management with Alberta to maintain runoff needed to sustain the Saskatchewan River and its tributaries. It called for a federal contribution of $6.3 million.
- The Prairie Provinces Water Board was established in 1948 through agreement with the three prairie provinces. It was to recommend how interprovincial waters should be used and how they should be allocated among the provinces. An earlier attempt by the provinces alone had failed.

- The Northern Transportation Company Ltd. was incorporated in 1947 to act as a common carrier in the Mackenzie watershed and western Arctic. (In 1985, the federal government announced that it would turn the company over to the private sector.)
- The Northern Canada Power Commission was established in 1948 to provide electric power to the Northwest Territories on a self-sustaining basis and later to Yukon. As well as operating hydro plants and diesel generators, the Commission installed water and sewage systems in some northern communities.
- An agreement with British Columbia established a Dominion-Provincial Board for the Fraser River Basin in 1948. The Board was chaired by the Department of Public Works and given a broad mandate to study the basin.
- Serious flooding in British Columbia's Lower Mainland (1948), in Manitoba's Red River Valley (1950) and in the Toronto area (1954) precipitated immediate relief efforts and led to new federal legislation and joint flood-control measures.
- Parliament passed the *Canada Water Conservation Assistance Act* in 1953, which provided for federal financial assistance (37.5 percent) for *major* provincial water storage projects. However, rigid requirements prevented its application to the Fraser River dyking program and to Manitoba's flood control projects; so special agreements outside the Act had to be drafted for sharing the costs of these projects. For the same reason, the South Saskatchewan Dam agreement was drawn up in 1958.
- Cooperative intergovernmental programs for regional economic development continued in the 1960s. The Agricultural Rehabilitation and Development Administration, created in 1961, allowed more generous conditions for federal assistance to the provinces than the *Canada Water Conservation Assistance Act*. Programs were delivered through regional federal entities where possible. The Central Mortgage and Housing Corporation's sewage treatment facilities program began in 1961, was expanded in subsequent years as the municipal infrastructure program, and then eliminated in 1980. The Atlantic Development Board, which grew out of the Gordon Commission's recommendations of 1958, initiated an Atlantic Provinces Water Resources Study, which eventually led to major improvements in municipal water infrastructure throughout Atlantic Canada.

Perhaps the best expression of the concerns of resource managers at this time can be found in the proceedings of the 1961 Resources for Tomorrow Conference. The theme of the conference, organized at the request of the Prime Minister, was set early:

> . . . our concern is not just with resources alone but with resources in relation to capital and labour, and our complex of institutions as they all, in turn, relate to the objectives of growth. . . We must be able to turn resources into income and employment opportunities. (5)

If "economic growth" was the theme, "multiple-use" and "coordination" were the means most often alluded to. The focus on intergovernmental coordination led to agreement among the federal and provincial governments to create the Canadian Council of Resource Ministers (now the Canadian Council of Resource and Environment Ministers). The early years of the Council saw special attention given to water resource publications.

Canada-United States Relations

As Ontario became desperate for electrical power to support industrial development, Canada entered into negotiations with the United States that led to the 1950 Niagara River Treaty, which divided flows available for power generation equally between Ontario and New York State.

Opposition from the railroads and Atlantic ports stalled the St. Lawrence Seaway and Power Development project in Congress. In the 1951 Speech from the Throne, Canada announced its intention to proceed with an all-Canadian project. Shortly thereafter, the federal government reached an agreement with Ontario to develop power in the St. Lawrence Rapids; the St. Lawrence Seaway Authority was established; and the International Joint Commission approved raising water levels in the river. Then the United States agreed to participate in the project. The power stations became operational in 1958, and the Seaway opened officially the following year.

While the Seaway development question was being considered, other boundary

water issues surfaced. Investigations by the International Columbia River Engineering Board were still in progress when the United States applied in 1951 to build Libby Dam on the Kootenay River, with a reservoir to extend 40 miles into Canada. The United States intended to offer monetary compensation for flooded lands but not to share project benefits. Objections raised on this side of the border gave rise to Canada's later claims to an equal share of downstream power and flood control benefits. The Libby Dam proposal was withdrawn in 1953.

During the Columbia River investigations, British Columbia announced arrangements with Kaiser Aluminum to develop power at the Arrow Lakes reach of the Columbia River. Because this development would have precluded other larger-scale coordinated development, federal authorities quickly drafted the *International River Improvements Act* (1955). The Act required federal approval for the construction of any facility in Canada that would alter flows crossing the boundary into the United States. This was sufficient to block the province's planned initiative. (6)

In 1959, the International Joint Commission adopted the principle that Canada could claim half the power and flood control benefits conferred on downstream United States interests by storage in Canada. Subsequently, the Columbia River Treaty was signed (1961). However, Ottawa was unable to implement it since British Columbia refused to recover half the downstream power benefits, insisting instead on selling the power to United States entities. This position contravened the federal government's longstanding policy of exporting electrical power only on a short-term basis. The National Energy Board, established in 1959 to consider all forms of energy export, considered this proposal. Eventually the federal government accepted the argument that electricity could be exported for long periods (over 25 years) without the risk of making permanent commitments.

A new federal policy announced in Parliament in 1963 allowed — even encouraged — the construction of major hydropower projects in Canada well before their output would be needed domestically, provided that markets could be found in the United States that would help pay project costs. Fear that cheaper nuclear power would soon preclude the potential development of Canada's vast remaining hydropower potential was a motivating factor. Not only did the federal policy change allow the Columbia River Treaty to be ratified in a 1964 Protocol, but it stimulated hydropower production elsewhere in the country. Manitoba took immediate advantage reaching federal-provincial agreements between 1963 and 1966 to carry out hydrologic and engineering investigations. These led to its Nelson River power program.

Economy and Environment: The Last Two Decades

The reorganization and consolidation of some federal water functions in the mid 1960s marks the first stirring of a broadly based movement that flowered within a few years and substantially modified the nature of water and related resource developments at all levels of government and society. A new relationship between Canadians and their environment was coming and, for better or worse, through conflict and compromise, water management was to be profoundly and permanently affected by it.

Reorganization

Federal organizational change came in two waves: the first consolidated water functions to make resource management more comprehensive; the second consolidated a number of renewable resources, including water, within an environmental framework.

Between 1965 and 1967, a series of reorganizations brought about a water sector in the new Department of Energy, Mines and Resources. The Canada Centre for Inland Waters was also created at this time at Burlington, Ontario. The freshwater side of this consolidation eventually became the Inland Waters Directorate. An "interim" Interdepartmental Committee on Water, chaired by Energy, Mines and Resources, was established in 1966 to coordinate federal water-related programs.

Recognizing the increasing scale of potential water developments and the inevitability of conflicts among users and jurisdictions, the federal government opted to play a more active role than allowed by most existing technical and financial assistance programs. The Minister of Energy, Mines and Resources in 1967 offered to carry out, at federal expense, comprehensive river basin planning experiments with the provinces. These were sub-

sequently negotiated as cost-shared, joint-planning agreements covering the Okanagan, Qu'Appelle and Saint John basins in anticipation of the *Canada Water Conservation Assistance Act* being repealed and the *Canada Water Act* being passed.

In 1971, Environment Canada was created from the Department of Fisheries and Forestry, and various units and branches from a number of other departments including Energy, Mines and Resources. An Environmental Protection Service was created to administer the amended *Fisheries Act*. This left the Inland Waters Directorate responsible for the remaining provisions of the *Canada Water Act* and with declining funding levels for its planning agreements. Various units of the department shifted over the intervening years: Fisheries and Marine (Oceans) left, Parks arrived, and Forestry transferred to the Department of Agriculture. The Inland Waters Directorate and the Environmental Protection Service remained separate, and often mutually suspicious, entities. Environment Canada itself endured a rapid succession of Ministers whose influence on government policy often appeared to be modest.

With a solid base of agricultural support in the Prairie provinces, the Prairie Farm Rehabilitation Administration resisted attempts to have its functions incorporated into the national water mandates of either Energy, Mines and Resources or Environment. In 1969, however, it was transferred to the new Department of Regional Economic Expansion. In accordance with the terms of a 1973 agreement between that department and Alberta, irrigation works were transferred to the province. Both the Prairie Farm Rehabilitation Administration and Environment Canada continued to serve on the Prairie Provinces Water Board, which was reconstituted in 1969 following the successful negotiation of an agreement regarding how the rivers flowing eastward between Alberta and Saskatchewan and between Saskatchewan and Manitoba would be shared.

Canada-United States Relations

Increasing evidence of lower Great Lakes pollution prompted the governments of Canada and the United States in 1964 to commission the most massive scientific investigation into water quality ever undertaken. The International Joint Commission's subsequent report on overenrichment led to restrictions on phosphates in laundry detergent in the *Canada Water Act* of 1970 and to the milestone international Great Lakes Water Quality Agreement of 1972.

Also during the 1960s, engineering firms and other private interests in both countries began to promote various schemes for transferring massive amounts of Canadian water into the Great Lakes and beyond to solve flooding, shortage and quality problems across the continent. These export schemes (NAWAPA, CeNAWP, GRAND Canal) provoked a hostile response from the Canadian public and were quickly rejected by both federal and provincial governments.

Such events indicated that the Canada-United States relationship on water matters was changing. For the foreseeable future, no more cooperative development projects, like the St. Lawrence Seaway and Power Development or the Columbia River Treaty, would be undertaken, although similar models were explored for a few more years in the Saint John and Yukon basins. Canada's role as the proverbial "hewer of wood, drawer of water" for a more advanced economy south of the border gave way to a more balanced partnership in which each country assumed responsibility for maintaining the integrity of a shared environment. Each country sought to protect itself from adverse transboundary effects resulting from its neighbour's actions whether it be a Garrison Diversion, Poplar thermal power, Skagit flooding or acid rain. As much as anything else, these events reflected the perception developing in both countries of water as environment as well as resource.

Northern Developments

Although water export was ruled out, federal and provincial governments continued to explore interbasin transfer of water from or within northern regions. The Northern Ontario Water Studies (1965-74), Nelson River Power investigations (1963-66) and Saskatchewan-Nelson Basin Board investigations (1967-72) are evidence of this activity. Alberta and Quebec pursued their own transfer possibilities. These were all supply-oriented engineering investigations, which encountered opposition from environmentalists and northern populations. When the provincial governments of Manitoba and Quebec decided to proceed with large-scale

water transfer and hydropower projects on the Churchill-Nelson and James Bay rivers, they were confronted with an unprecedented move by the Department of Indian Affairs and Northern Development to fund the legal defence of the affected Indian communities. As a result, settlements were reached ensuring these communities a considerable measure of protection and participation in the economic developments associated with the projects.

Water pollution and northern project issues made such an impression on the Government of Canada that five pieces of legislation were passed in 1970: the *Arctic Waters Pollution Prevention Act*, *Canada Water Act*, *Northern Inland Waters Act*, amendments to the *Canada Shipping Act* and amendments to the *Fisheries Act*.

Recent Initiatives

During the past decade, several water-related policies and programs were initiated or amended, some of which are noteworthy:

- The provincial and federal governments conducted cooperative environmental impact assessments after the provinces had decided to proceed with major hydro projects on Lake Winnipeg, Churchill-Nelson Rivers, and the Peace River. Gradually, a more structured Environmental Assessment and Review Process evolved for projects involving federal funds or jurisdiction.
- In 1975, Cabinet approved the national Flood Damage Reduction Program to discourage new investment in vulnerable flood-risk areas. Seven provinces and one territory became participants.
- Parliament passed the *Environmental Contaminants Act* in 1975, providing grounds for restricting the manufacture and distribution of harmful chemicals. To date, five substances have been listed under the Act.
- Between 1979 and 1984, the territorial governments participated as full partners in the first systematic intergovernmental planning agreements regarding the Mackenzie and Yukon basins.
- The Minister of Indian Affairs and Northern Development indicated in 1974 that the government was prepared to negotiate native land claims including provisions for self-government. Recent agreements with the Inuvialuit in the western Arctic and with the Cree and Naskapi in Quebec explicitly retain Crown ownership of waters, but provide for native participation in related management decisions.
- Canadian drinking water guidelines, first prepared in 1968 and revised ten years later by federal and provincial health officials, are being expanded slowly in response to suggestions that their scope and authority should be greatly increased. Uniform guidelines for water quality generally is the work of a federal-provincial task force.
- In the late 1970s, budget cutbacks forced federal water quality monitoring to retreat to interjurisdictional boundary locations and to areas subject to formal basin agreements. In 1982, Cabinet approved the reestablishment of a national network on a cost-sharing basis similar to that in place for national water quantity monitoring. Federal-provincial water quality monitoring agreements are being negotiated toward that end.
- A Canadian Heritage Rivers System was established in 1983, which enables provinces and territories to nominate waterways for protection.

As such initiatives have multiplied, the need for effective coordination among federal agencies has become more critical. In 1978, Cabinet approved a Federal Policy Statement on Inland Waters. Although the statement served to publicize a number of current agency practices, it was clearly not the product of a systematic review of either individual programs or federal water policy as a whole. Like the Interdepartmental Committee on Water, the statement reflected mostly the views of one department, Environment.

Summary

Our historical review in this chapter leads to some general observations about federal water policy evolution.

First, water-related projects have long been used to secure Canadian nation-building objectives, which included facilitating commerce, resisting American incursions and populating the western interior. However, water was not a policy area in its own right, but a support to various activities like fisheries, agriculture and navigation, administered by various agencies. Only in the past three decades, with the proliferation of water-use issues, have laws and institutions begun to focus on water management generally and on coordinating the

many different interests of federal agencies.

Second, intergovernmental cooperation in water matters throughout this century has been impressive. Early conflicts with the United States were resolved by the terms and principles of the Boundary Waters Treaty of 1909; and conflicts with provinces over inland fisheries, hydro development and the transfer of natural resources were resolved by 1930. The fruits of cooperative development multiplied after World War II: the federal government entered into a number of arrangements with the United States, including the St. Lawrence Seaway, the Columbia Treaty and more recently the Great Lakes Water Quality Agreement; and the federal government cooperated with the provincial and territorial governments on a wide variety of projects and programs including irrigation, flood control, waste treatment, river basin planning and hydrometric data collection. The times and the issues have changed over this period, but cooperative arrangements have continued apace, with adjustments as needed to satisfy the participants.

Finally, while the federal government's activities in environmental matters have expanded, the power of the agencies responsible for those activities is modest relative to many other government departments. This is attributable to the recent recognition of environmental problems as governmental concerns and the federal government's constrained constitutional mandate for dealing with them. Thus, the federal role in environmental matters, including water resource management, continues to evolve.

Part II

Water Resources, Uses and Pressures

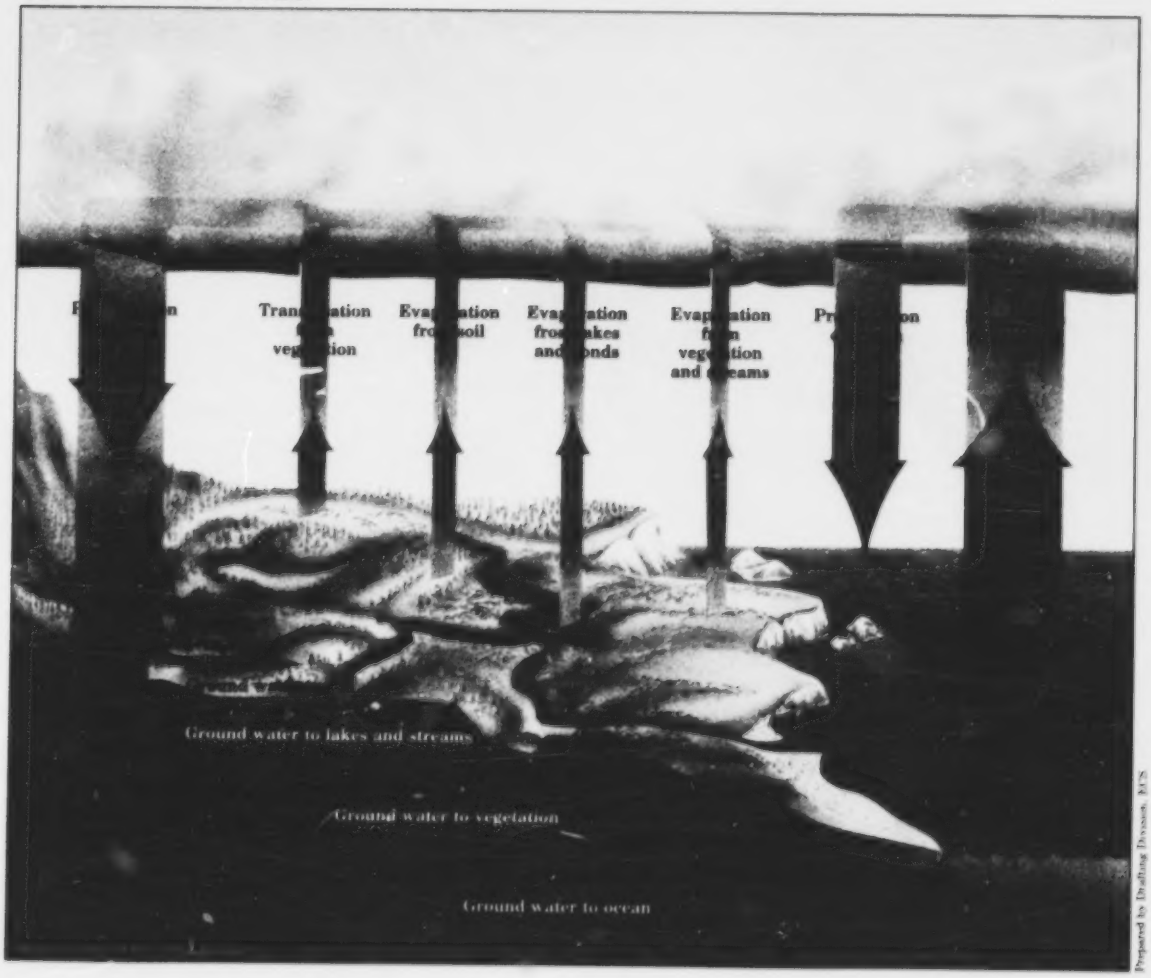
PART II
WATER RESOURCES, USES AND PRESSURES

We must establish some basic understanding about the state of Canada's water resources before addressing federal policy related to their management.

Accordingly, Part II reviews the nature and extent of Canada's freshwater resources, the demands we make upon them, and the consequences of those demands for their quantity and quality. Part II consists of three chapters. Chapter 3 provides a broad geographical overview of Canada's water resources, especially their natural properties. Chapter 4 addresses the many uses to which water is put, the conflicts among uses and future as well as present balance between availability and use. And Chapter 5 discusses a number of water quality issues causing widespread concern.

To assess water resources and uses, we have divided Canada into five primary or ocean basin regions and twenty-five secondary or river basin regions.

Figure 3.1
THE WATER CYCLE



Chapter Three

Canada's Freshwater Resources

Water is the lifeblood of our land.

DEPARTMENT OF NATURAL RESOURCES
GOVERNMENT OF MANITOBA

This chapter describes Canada's freshwater resources, focusing mostly on their natural quantity and quality and their regional distribution patterns. Our overview of such a complex subject provides only enough detail to establish a general picture and to support subsequent analysis of water policy issues.

Water Quantity

The earth's freshwater resources have remained essentially unchanged since genesis. Oceans and inland seas contain most of the world's water. Less than 3 percent is fresh, and most of that is inaccessible, locked in polar ice caps and deep underground. Little more than one-hundredth of one percent of the earth's water is in lakes, rivers, the soil and the atmosphere.

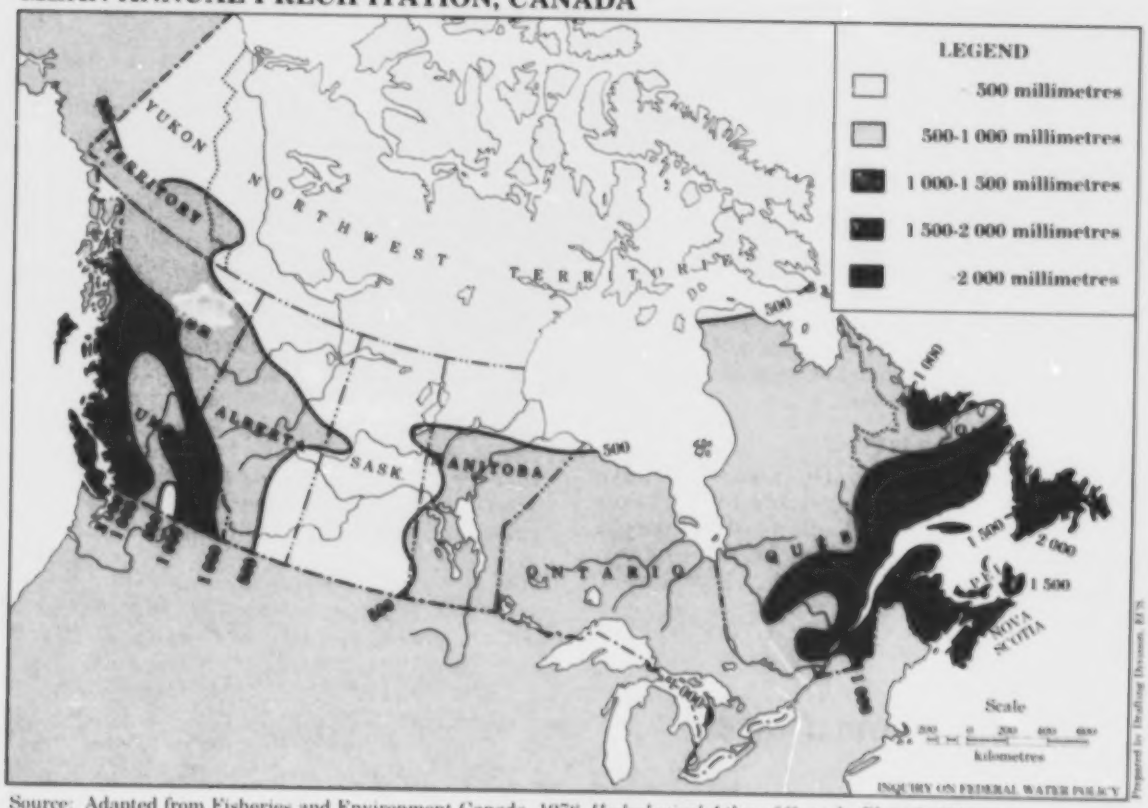
Table 3.1 summarizes the earth's water supply. Most of the earth's freshwater is stored in large lakes; the rest circulates dynamically: it evaporates from the earth's surface and is transpired from plants, it falls as rain or snow, it percolates into the ground, it travels through rivers and lakes and eventually returns to the ocean. This great recycling process, which is so vital to life on earth, is called the hydrologic cycle. (See Figure 3.1) Simple in concept, the many alternative routes within the cycle make the science of hydrology very complex.

Table 3.1
ESTIMATED WORLD WATER BUDGET

Form	Volume (000s km³)	% of Total
Salt Water		
oceans	1,320,000	97.2
inland seas	104	—
Fresh Water		
polar ice and glaciers	29,200	2.1
underground (to 4,000 m.)	8,350	.6
lakes	125	.01
soil moisture	40	
atmosphere	13	
rivers	1.25	

Source: Adapted from Nace, R.L. 1967. "Are We Running Out of Water?" *U.S. Geological Survey, Circular 536.* Washington; and from Baumgartner, A. and E. Reichel. 1975. *The World Water Balance.* Munich.

Figure 3.2
MEAN ANNUAL PRECIPITATION, CANADA



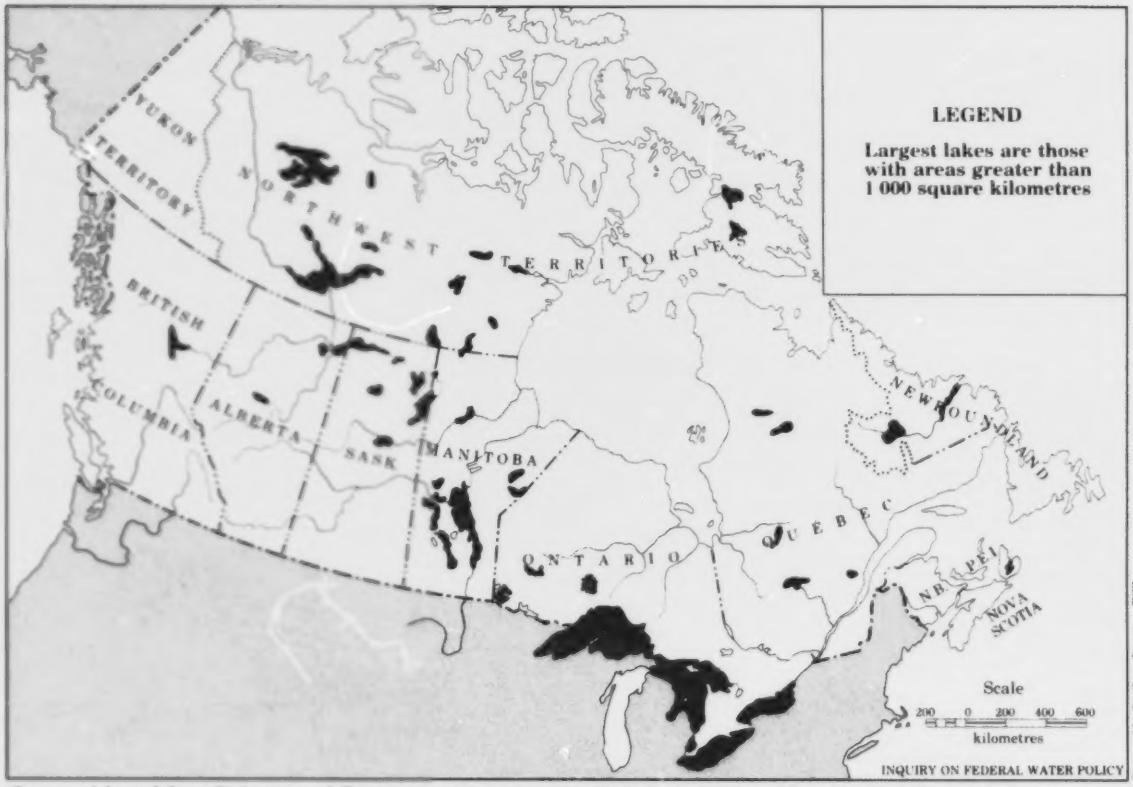
Source: Adapted from Fisheries and Environment Canada. 1978. *Hydrological Atlas of Canada*. Plate 3. Ottawa.
(Adjusted for elevation, snow to water ratio and undercatch by Atmospheric Environment Service).

Climate

Climate is the primary determinant of hydrological conditions. In Canada humid and mild Pacific conditions are limited to a narrow band along the west coast. As the warm, moist air is forced over successive mountain ranges, it loses much of its moisture, becoming relatively dry by the time it reaches the prairies. The same mountain ranges protect the coast and intermontane valleys from cold Arctic air. In the continental interior, where no barriers exist to the flow of air from north or south, seasonal temperatures are more extreme. Further east, large water bodies like the Great Lakes and the Atlantic Ocean moderate seasonal temperatures and increase precipitation.

Average annual precipitation for Canada is about 600 millimetres (mm). (1) It ranges from 100 mm in the high Arctic to over 3,500 mm along the Pacific coast. (See Figure 3.2.) Over one-third of Canada's precipitation falls as snow, which is held until spring runoff. Almost half of our precipitation is lost by evaporation from land and water surfaces and by transpiration from plants. The remaining portion (averaging roughly 330 mm per year) runs off in rivers and streams, sometimes after residence in lakes, wetlands or aquifers. These are the waters with which this report is concerned, and to which we now turn.

Figure 3.3
LARGEST LAKES, CANADA



Source: Adapted from Fisheries and Environment Canada.1978. *Hydrological Atlas of Canada*. Plate 18. Ottawa.

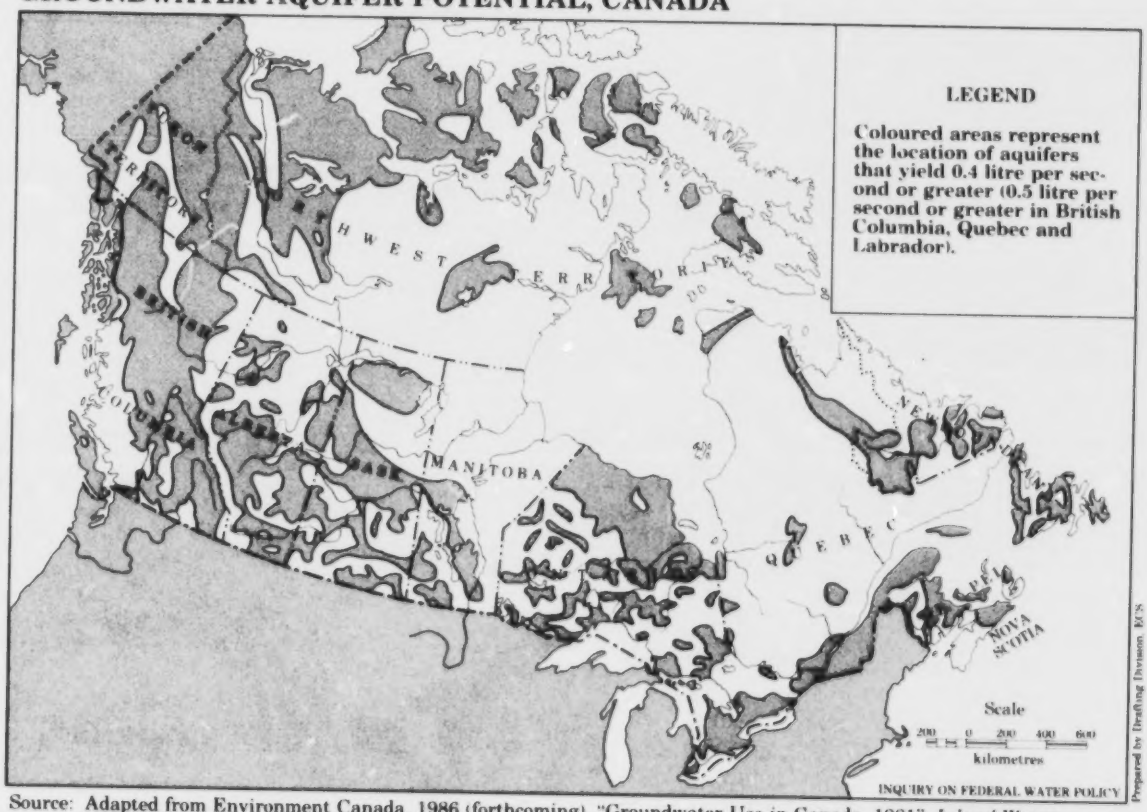
Lakes and Wetlands

Canada is known for its lakes, which cover fully 8 percent of the country — more lake area than any other country in the world. Wetlands increase this figure to almost 20 percent. Canada has or shares with the United States seven of the world's largest lakes, and has forty-five lakes with areas larger than 1,000 square kilometres. (See Figure 3.3.) Most of these extend in an arc along the outer edge of the Precambrian Shield, where meltwaters ponded thousands of years ago as ice fronts retreated. Thousands of smaller lakes and bogs dot the landscape from one end of the country to another. (2)

Lakes store water during periods of high precipitation and snowmelt, and release it gradually, allowing rivers to survive through periods of low precipitation. Wetlands, which act as sponges, also store water. However, lakes and reservoirs lose water through evaporation because of their large surface areas. They also modify local temperatures and precipitation. Storage of this kind is so valuable that engineers have built dams and other works to supplement natural controls of existing lakes and to create new lakes.

Although large lakes are effective in regulating water flow, their own water levels are not static. Wind-driven currents can cause fluctuations, sometimes increasing levels at one end with resulting erosion and flood damage. Fluctuations in lake levels can cause problems for shoreline communities and conflicts among water users.

Figure 3.4
GROUNDWATER AQUIFER POTENTIAL, CANADA


LEGEND
Coloured areas represent the location of aquifers that yield 0.4 litre per second or greater (0.5 litre per second or greater in British Columbia, Quebec and Labrador).
MANITOBA
QUEBEC
NOVA SCOTIA
Scale
200 0 200 400 600
kilometres
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Prepared by Drafting Division IEC/S

Source: Adapted from Environment Canada. 1986 (forthcoming). "Groundwater Use in Canada, 1981". *Inland Waters Directorate Scientific Series* by P.J. Hess.

Groundwater

Below the surface of the earth lies a huge reservoir of water, perhaps many times larger than the amount of water on the surface and in the atmosphere.

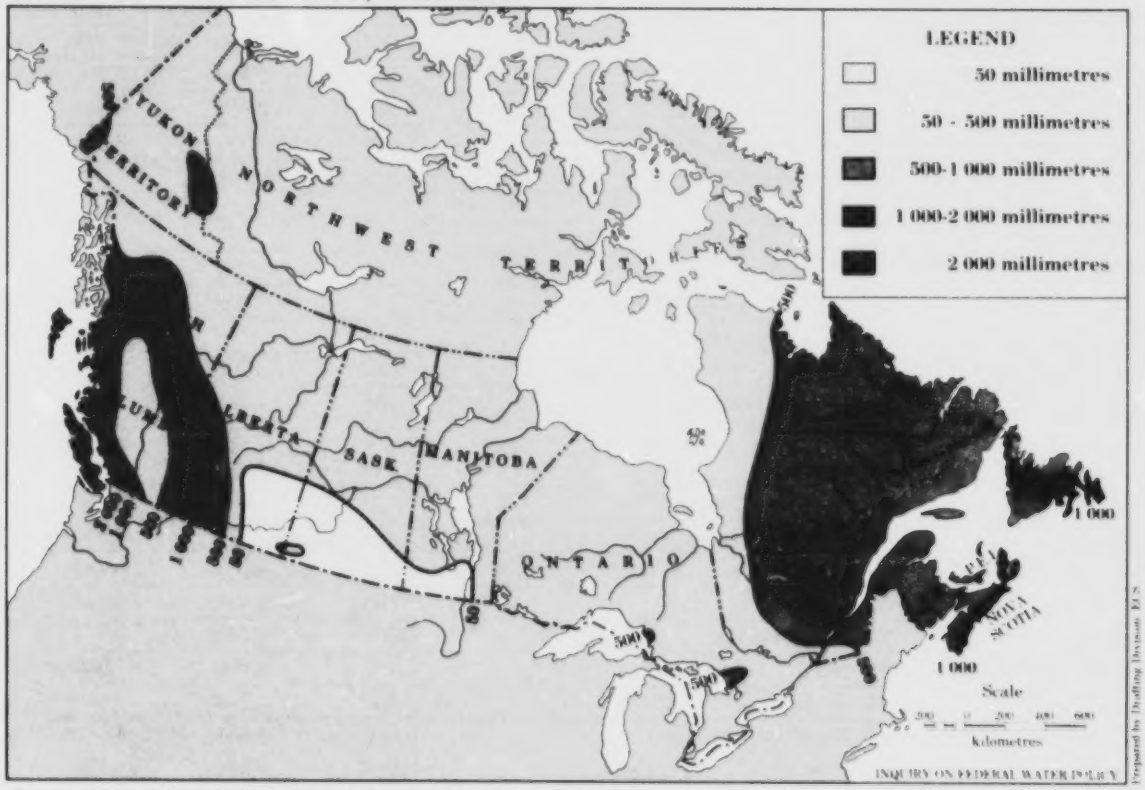
Groundwater comes from precipitation that has filtered down through the soil until it reaches the water table. If the water moves at measurable speeds and can be withdrawn at significant rates, this zone is called an aquifer. Aquifers generally consist of unconsolidated material like sand and gravel, or porous or fractured rock. They vary in size and distance from the surface. Most aquifers used in Canada are small and relatively shallow. (3)

Groundwater is important for two reasons. First, like surface water bodies, it feeds streams and rivers, sometimes sustaining flow during periods of low precipitation. Second, it can be intercepted by wells, thus supplying water of constant temperature and quality to millions of rural users and many communities.

Figure 3.4 shows the distribution of aquifers in Canada that yield at least 0.4 litres per second. This rate provides an adequate supply for rural domestic use, but a greater yield is required for most other uses. (4)

No national inventory of groundwater yield exists, but some information has been accumulated from the records of water well drillers. Hydrogeological knowledge is increasing and some mapping programs have been initiated.

Figure 3.5
MEAN ANNUAL RUNOFF, CANADA



Source: Adapted from Fisheries and Environment Canada. 1978. *Hydrological Atlas of Canada*. Plate 24. Ottawa, and from Acres International Ltd., 1984. *Hydrologic Methodologies for Small Hydro at Ungauged Sites*. Phase 1, Plate 2. Niagara Falls.

Surface Runoff

The flow of water in rivers is the best single measure of water supply because it is renewed through the hydrologic cycle. Only small portions of our lakes and underground reservoirs are renewed annually. For example, ninety-nine percent of the water in the Great Lakes is a legacy from melting ice sheets of the Pleistocene epoch; only about 1 percent is renewed through precipitation and the rivers that feed and drain the Lakes.

On an average annual basis, Canada's rivers discharge close to 9 percent of the world's renewable water supply, roughly 105,000 cubic metres per second (m^3/s). In an area encompassing about 7 percent of the world's landmass, this is not disproportionate; but it is generous in per capita terms since Canada has only 1 percent of the world's population. By way of comparison, the world's largest river, the Amazon, discharges about 18 percent of the world's renewable water supply; the U.S.S.R. river systems discharge 13 percent; and the United States discharges 8 percent.

Given the limited information available on other components of the hydrologic cycle and the significance of renewable supply, most of the following discussion focuses on river flows. Figure 3.5 shows the average annual runoff rates. High runoff rates in most of British Columbia are due to abundant precipitation. Runoff rates are lowest in the southern prairies due to little precipi-

Table 3.2
CANADIAN ANNUAL RIVER FLOW RATES

Ocean Basin Region	River Basin Region	Annual Flow Rates[a] (cubic metres per second) Reliable[b] (Low)	Mean	High[c]
Pacific	1. Pacific Coastal	12,570	16,390	20,200
	2. Fraser-Lower Mainland[d]	3,044	3,972	4,900
	3. Okanagan-Similkameen[e]	31	74	116
	4. Columbia[e]	1,644	2,009	2,373
	5. Yukon[e]	1,806	2,506	3,206
Arctic	6. Peace-Athabasca	1,862	2,903	3,946
	7. Lower Mackenzie[f]	6,114	7,337	8,561
	8. Arctic Coast-Islands	5,920	10,251	14,582
Gulf of Mexico	9. Missouri[e]	3	12	41
Hudson Bay	10. North Saskatchewan	160	234	373
	11. South Saskatchewan	147	239	418
	12. Assiniboine-Red[e]	16	50	188
	13. Winnipeg[de]	382	758	1,137
	14. Lower Sask.-Nelson[ef]	1,108	1,911	2,714
	15. Churchill[d]	323	701	1,070
	16. Keewatin	2,945	3,876	4,806
	17. Northern Ontario[d]	3,733	5,995	8,258
	18. Northern Quebec[d]	12,820	16,830	20,830
Atlantic	19. Great Lakes	2,403	3,067	3,733
	20. Ottawa	1,390	1,990	2,590
	21. St. Lawrence[ef]	1,504	2,140	2,777
	22. North Shore-Gaspé	6,437	8,706	10,980
	23. St. John-St. Croix[e]	507	779	1,050
	24. Maritime Coastal	2,079	3,081	4,085
	25. Newfoundland-Labrador	6,908	9,324	11,739
CANADA		**75,856**	**105,135**	**134,674**

Note:
[a] From recorded flows except in Prairie basins where natural flows have been estimated.
[b] Flow equalled or exceeded in 19 years out of 20.
[c] Flow equalled or exceeded in 1 year out of 20.
[d] Excludes flow transferred into neighboring basin region; because this flow is recorded in importing basin, transfers have little effect on national total.
[e] Excludes inflow from United States portion of basin region.
[f] Excludes inflow from upper basin region.

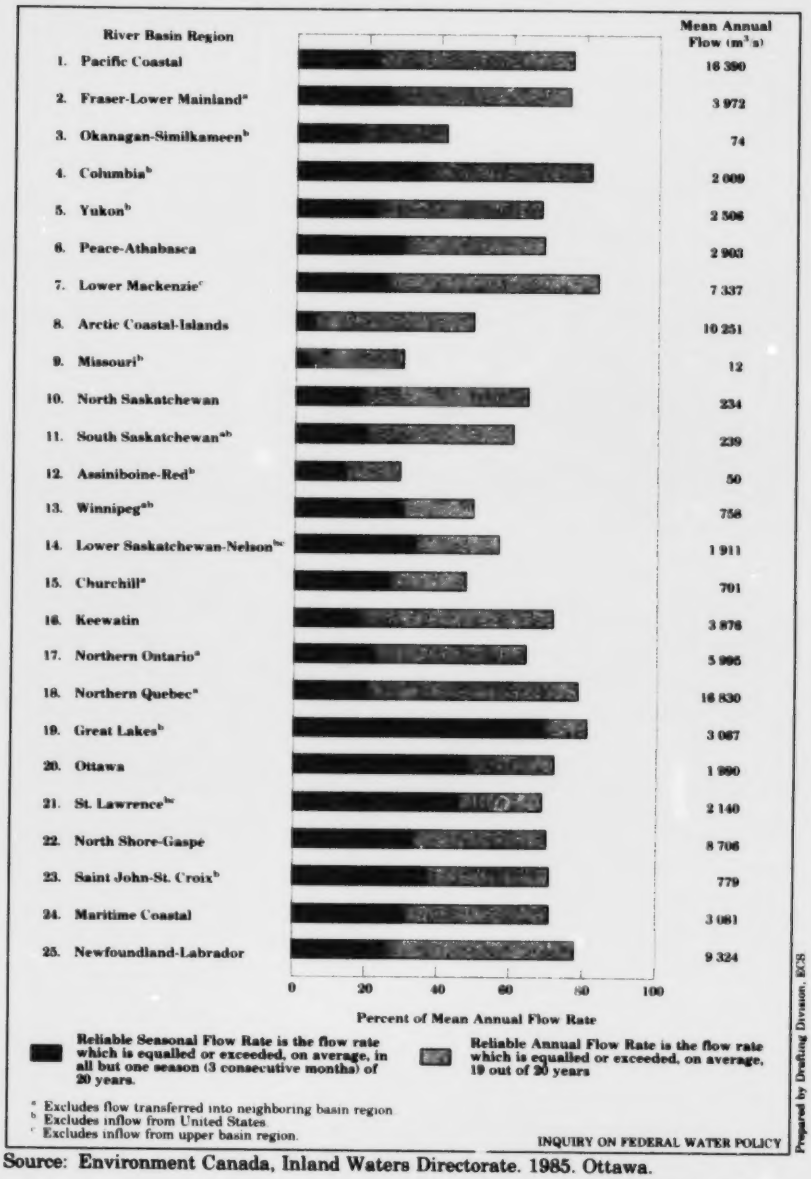
Source: Inland Waters Directorate, Environment Canada.

tation. Indeed, parts of the prairie grasslands produce no runoff except in wet years. Fortunately for prairie agriculture, precipitation peaks in the summer months when it is most useful for crop growth. Although runoff rates throughout the north are low, they represent a high proportion of precipitation given low temperature and little evaporation.

Average annual flow data mask the fluctuations that occur from year to year and season to season. So we have estimated high and low (or reliable) annual flows from recorded flows in twenty-five river basins. A basin is the geographical area drained by a river and its tributaries. These are shown in Table 3.2.

Table 3.2 shows that most high flows are about one and one-third times the average annual flow, and that reliable flows are about two-thirds of the average annual flow. Wider variations are found mainly in the dry prairie basins.

Figure 3.6
RELIABILITY OF STREAMFLOW


River Basin Region
Mean Annual Flow (m³/s)
1. Pacific Coastal 16 390
2. Fraser-Lower Mainland[a] 3 972
3. Okanagan-Similkameen[b] 74
4. Columbia[b] 2 009
5. Yukon[b] 2 508
6. Peace-Athabasca 2 903
7. Lower Mackenzie[c] 7 337
8. Arctic Coastal-Islands 10 251
9. Missouri[b] 12
10. North Saskatchewan 234
11. South Saskatchewan[a,b] 239
12. Assiniboine-Red[b] 50
13. Winnipeg[a,b] 758
14. Lower Saskatchewan-Nelson[b,c] 1 911
15. Churchill[a] 701
16. Keewatin 3 876
17. Northern Ontario[a] 5 995
18. Northern Quebec[a] 16 830
19. Great Lakes[b] 3 087
20. Ottawa 1 990
21. St. Lawrence[b,c] 2 140
22. North Shore-Gaspé 8 706
23. Saint John-St. Croix[b] 779
24. Maritime Coastal 3 081
25. Newfoundland-Labrador 9 324
0 20 40 60 80 100
Percent of Mean Annual Flow Rate
Reliable Seasonal Flow Rate is the flow rate which is equalled or exceeded, on average, in all but one season (3 consecutive months) of 20 years.
Reliable Annual Flow Rate is the flow rate which is equalled or exceeded, on average, 19 out of 20 years
[a] Excludes flow transferred into neighboring basin region.
[b] Excludes inflow from United States.
[c] Excludes inflow from upper basin region.
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Prepared by Drafting Division, EC/S

Source: Environment Canada, Inland Waters Directorate. 1985. Ottawa.

Figure 3.6 illustrates the significance of annual and seasonal variations in flow. Reliable annual flows, as we define them, fall short of the average flow for all rivers, but the shortfall is especially marked in prairie rivers. Reliable seasonal flows are also relatively low on the prairies and in northern basins, where freezing reduces flows significantly in winter. In contrast, basins with abundant lake storage (Lower Saskatchewan-Nelson, Great Lakes) maintain relatively steady flow rates throughout the year. We should emphasize that all these variations in flows refer to the outlets of large basins or of groups of basins, where the runoff extremes in one watershed are often offset by different patterns of runoff in others. Variations in individual streams and tributaries are even more extreme. (5)

On a per capita basis, Canada has abundant water supply — on average, almost 360,000 litres per person per day. But regional variations are enormous. The largest per capita supplies are in the north and in the sparsely settled areas on the eastern and western extremities. On the basis of seasonal flow rates, the North Saskatchewan, South Saskatchewan, Assiniboine-Red and Missouri basins have less than 2,500 litres per capita per day.

Water Quality

Pure water is not found in nature. As it makes its way through the various phases of the hydrologic cycle, water accumulates various substances in suspension, solution and colloidal dispersion.

Droplets of water in the atmosphere incorporate dissolved gases and dust particles. Falling as precipitation, water may trap or dissolve other substances. Upon reaching the ground, it flows over the surface in its journey to the sea, picking up silt, bacteria and decaying matter; it also becomes mixed with water which has percolated through soil and rock and which has dissolved various minerals.

The quality of water is changed by the many natural substances with which it comes in contact A river may become turbid and colored. Where its velocity is reduced, as upon entering a lake or swamp, suspended sediment settles out; color may be bleached out by exposure to sunlight. Decomposition of organic material by bacteria depletes oxygen in the water and increases its dissolved mineral content. In some lakes, these processes may be sufficient to give water a distinct taste and odor; in lakes with heavy concentrations of nutrients, growth of algae and weeds and depletion of oxygen content may occur during summer warming.

Changes in surface water quality are most pronounced during extreme conditions. During periods of heavy rainfall and surface runoff, erosion increases the amount of suspended solids. Animal wastes are also swept into the channel. During periods of drought, dissolved minerals are concentrated on the surface as water evaporates.

Groundwater qualities differ from those of surface water. Because it filters through soil and rock, groundwater is almost free of suspended material; and because it has no organic matter or dissolved oxygen, bacterial activity is minimal. But it picks up carbon dioxide as it percolates through decaying material near the surface, and this permits it to dissolve minerals such as calcium, magnesium, iron and arsenic. Thus, water in deep aquifers tends to be hard.

The characteristics of groundwater do not change significantly from season to season or with surface runoff conditions. Its temperature remains almost constant and its flow steady where undisturbed. In rare occurrences, notably in the Rocky Mountains, springs emerge hot and heavily mineralized from deep volcanic sources.

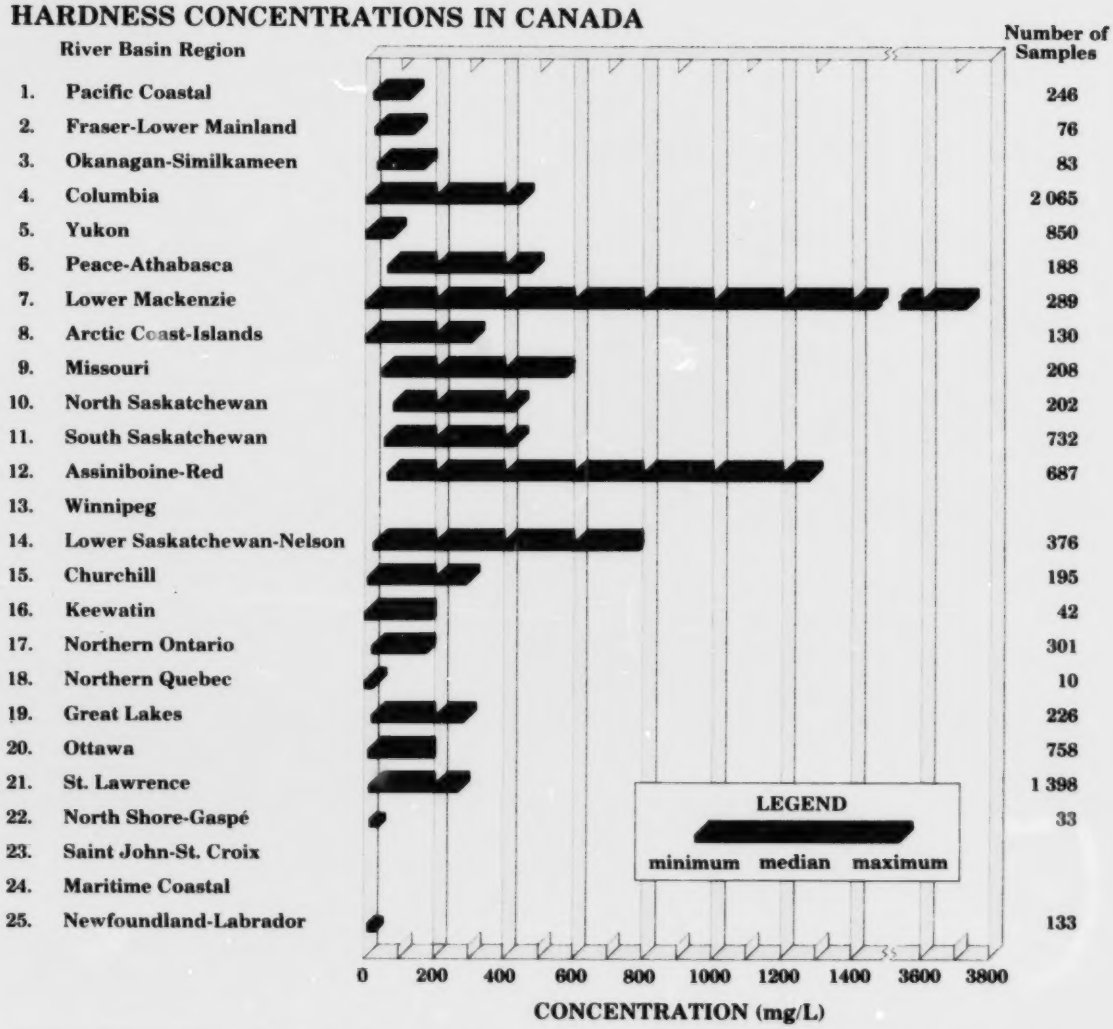
The constituents that occur naturally in water have various effects, some of which are desirable, some undesirable. Even in their natural state, water resources normally contain measurable amounts (parts per million) of dissolved gases and major ions, as well as traces (parts per billion or trillion) of other substances such as heavy metals and organic compounds. Water quality is also characterized by physical properties such as acidity (pH), color and conductivity. A description of the many significant water quality parameters is beyond the scope of this report, but one of these, hardness, is discussed below for illustrative purposes.(6)

Hardness in water inhibits lather formation during washing and causes costly boiler scale to form as calcium and magnesium ions precipitate out when the water is heated. But soft water with *low* concentrations of calcium can also be problematic since it is less effective in buffering hydrogen ion concentration from acid inputs. Furthermore, the toxic effect of many heavy metals is greater in soft water.

Hardness concentration values for various basins across Canada are given in Figure 3.7. Very soft waters occur in the Atlantic provinces; the concentrations found there have been so stable that, with the exception of Newfoundland, routine monitoring for water hardness in the Atlantic provinces has ceased. Hard waters are found predominantly in the prairies, with the highest levels being found in the Missouri and Red basins. Moderate hardness values are found throughout the rest of Canada.

Assessing the quality of Canadian waters is clearly much more difficult than assessing their quantity. Not only are there more variables — physical, chemical and biological — to be measured, but human activities, especially the introduction of thousands of synthetic compounds, have complicated the task enormously. Variation in these parameters is so pronounced that a watercourse must be sampled repeatedly and in many locations before its quality can be reliably determined.

Figure 3.7
HARDNESS CONCENTRATIONS IN CANADA



Source: Environment Canada, Inland Waters Directorate. 1985. "Background Information on Water Quality in Selected Canadian River Basins". Unpublished paper by R.E. Kwiatkowski. Ottawa.

Prepared by Drafting Division, ECS

INQUIRY ON FEDERAL WATER POLICY

Human Impacts

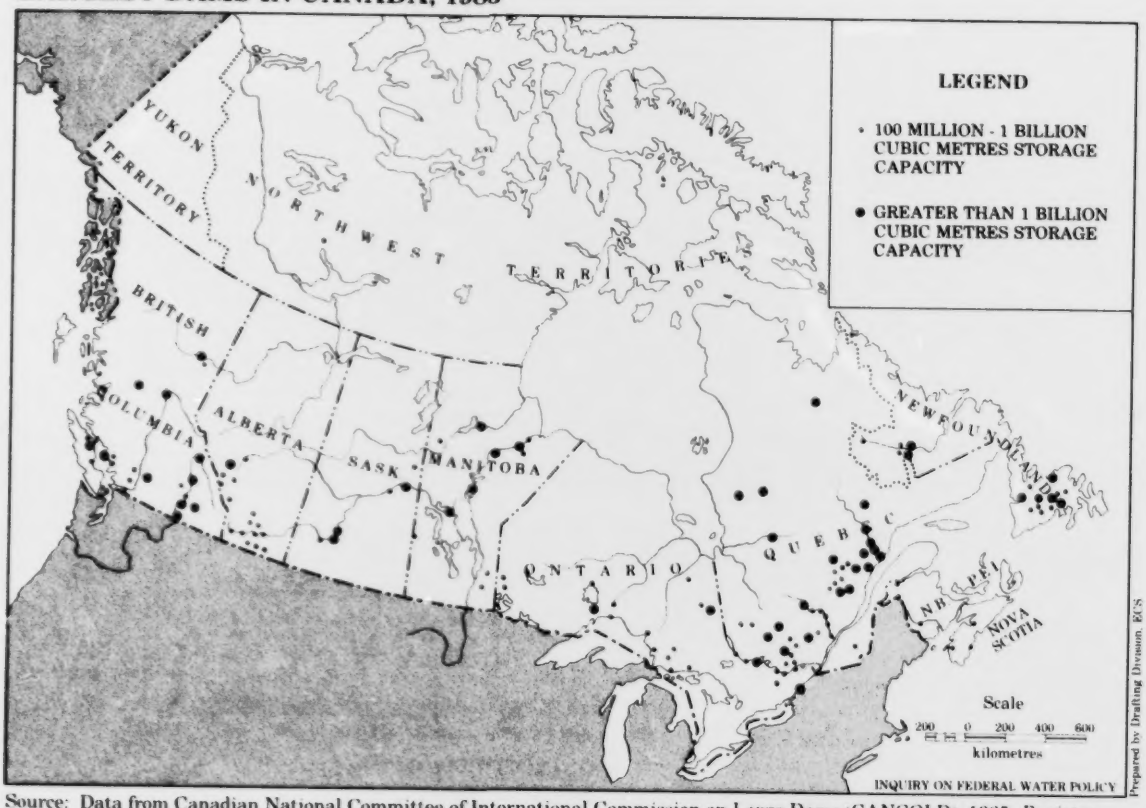
In addition to the natural processes that cause water quantity and quality to vary over time and space, human activity has had an increasing impact. Many of these activities simply modify natural phenomena, such as drainage works that accelerate runoff, erosion and sedimentation and reduce groundwater levels, or reservoirs that flood northern lands and release heavy metals like mercury into the aquatic environment. Other activities have a much more pronounced effect.

Dams and Diversions

Dykes, channel modifications, dams and diversions are used to regulate surface waters. Dykes are usually used on a local scale for flood control. Channel modifications are more significant for the water regime where they are associated with extensive land drainage projects. Major dams and interbasin diversions or transfers have a substantial impact on Canadian water resources. Dams are built primarily to regulate river flows and lake levels seasonally to assure the availability of water *when* it is most in demand; interbasin transfers are built to augment flows *where* they are most needed.

Canada is blessed with such abundant natural water storage that artificial storage is small by comparison; but it is growing

Figure 3.8
LARGEST DAMS IN CANADA, 1985



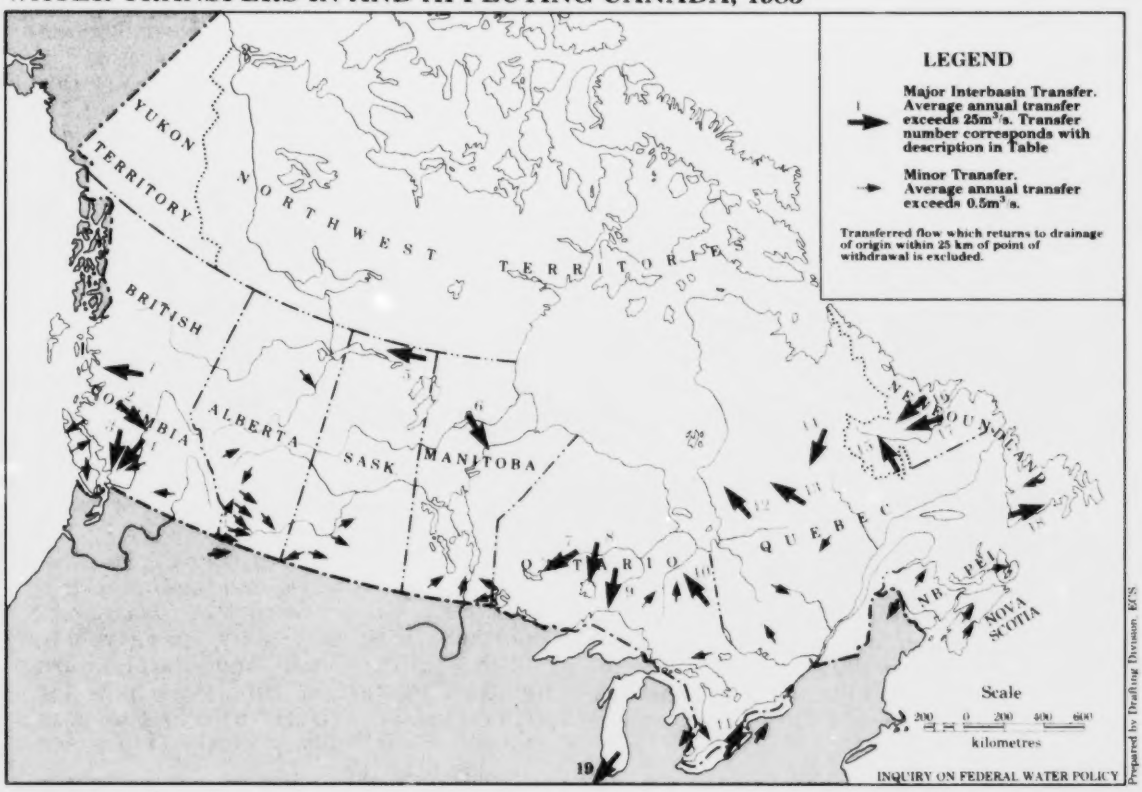
Source: Data from Canadian National Committee of International Commission on Large Dams (CANCOLD). 1985. *Register of Dams in Canada*.

rapidly. Figure 3.8 indicates the location of only the largest projects, those with gross storage capacity exceeding 100 million cubic metres (97 dams) and 1 billion cubic metres (53 dams). Most of the latter have been constructed since 1950. Storage projects are concentrated in Quebec, followed by British Columbia and Newfoundland-Labrador. Over 80 percent of Canada's largest dams serve hydroelectric power purposes. Irrigation accounts for 7 percent and a smaller number provide municipal and industrial water supply. Flood control is an important function of the few multiple-purpose projects. (7)

Interbasin transfers have become significant for water availability and involve enormous amounts of water. In fact, if all of the flow transferred between basins within Canada — 4,400 cubic metres per second — were concentrated into one river, it would be Canada's third largest, after the St. Lawrence and Mackenzie. This total is greater than the combined total of water transfers in the next two leading countries, the United States and the U.S.S.R. (8)

Fifty-four interbasin transfers have been identified, the largest of which tend to be the most recent: Churchill River Diversion in Manitoba, La Grande Project in Quebec, and Churchill Falls Project in Labrador. (See Figure 3.9). Most projects have been developed to generate and move low-cost electricity, not water, to southern markets.

Figure 3.9
WATER TRANSFERS IN AND AFFECTING CANADA, 1985



No.	Jurisdiction	Project	Contributing Basin(s)	Receiving Basin	Average Annual Transfer (m^3/s)	Uses	Operational Date	Owner
1	B.C.	Kemano 1	Nechako (Fraser)	Kemano	102	Hydro	1952	Alcan Ltd.
2	B.C.		Bridge	Seton Lake	92	Hydro	(1934)1959	B.C. Hydro
3	B.C.		Cheakamus	Squamish	37	Hydro	1957	B.C. Hydro
4	B.C.		Coquitlam Lake	Buntzen Lake	28	Hydro	(1902)1912	B.C. Hydro
5	Sask.		Tazin Lake	Charlot (L. Athabasca)	25	Hydro	1958	Eldorado Nuclear
6	Man.	Churchill Diversion	Churchill (Southern Indian Lake)	Rat-Burntwood (Nelson)	752	Hydro	1976	Manitoba Hydro
7	Ont.		L. St. Joseph (Albany)	Root (Winnipeg)	86	Hydro	1957	Ontario Hydro
8	Ont.		Ogoki (Albany)	Lake Nipigon (Superior)	120	Hydro	1943	Ontario Hydro
9	Ont.		Long Lake (Albany)	Lake Superior	38	Hydro Logging	1939	Ontario Hydro
10	Ont.		Little Abitibi (Moose)	Abitibi (Moose)	40	Hydro	1963	Ontario Hydro
11	Ont.	Welland Canal	Lake Erie	Lake Ontario	250	Hydro Navig.	(1829)1951	Govt. of Canada
12	Que.	James Bay	Eastmain-Opinaca	La Grande	798	Hydro	1980	J.B. Energy Corp.
13	Que.	James Bay	Frégate	La Grande	31	Hydro	1982	J.B. Energy Corp.
14	Que.	James Bay	Caniapiscau	La Grande	771	Hydro	1983	J.B. Energy Corp.
15	Nfld.	Churchill Falls	Julian-Unknown	Churchill	196	Hydro	1971	Nfld. & Lab. Hydro
16	Nfld.	Churchill Falls	Naskaupi	Churchill	200	Hydro	1971	Nfld. & Lab. Hydro
17	Nfld.	Churchill Falls	Kanairiktok	Churchill	130	Hydro	1971	Nfld. & Lab. Hydro
18	Nfld.	Bay d'Espoir	Victoria, White Bear, Grey and Salmon	Northwest Brook (Bay d'Espoir)	185	Hydro	1989	Nfld. &Lab. Hydro
19	Illinois	Chicago Diversion	Lake Michigan	Illinois (Mississippi)	90	Municipal Sanitation	(1848)1900	Chicago San. Dist.

Source: Adapted from Quinn, Frank. 1981. "Water Transfers–Canadian Style". *Canadian Water Resources Journal*. Vol. 6 No. 1.

Pollution

Natural water regimes have been modified, not only by structural controls like dams and transfers, but by land use changes as well. Just as forest cover gave way to the plough in many parts of Canada during the settlement period, agriculture has recently been encroached upon by urban, suburban and transportation land uses, which alter the rate and quality of water discharging to streams and infiltrating the ground. These impacts are heaviest in the settled southern areas of Canada where natural waterways are being overloaded and contaminated by the products of modern civilization.

The quality of Canadian waters remains generally high, but serious pollution problems have emerged over the past few decades in agricultural, mining and industrial regions. The sources of pollution include microorganisms (bacteria, viruses, parasites), various degradable pollutants (sewage and industrial wastes, fertilizers, etc.) toxic contaminants (organic and inorganic compounds) and those diffuse pollutants transported long distances through atmospheric processes. These are discussed in detail in Chapter 5.

Regional Patterns

Canada's rivers discharge through four great ocean basin regions — Pacific, Arctic, Hudson Bay and Atlantic — with a minor flow to the Gulf of Mexico. About half of this surface runoff is toward the north, away from population, agricultural and industrial centers along the country's southern margins. (See Figure 3.10)

Pacific Drainage

Almost one-quarter of Canada's total river discharge originates within the Pacific drainage area west of the Rocky Mountain divide. The largest rivers are the Fraser, Yukon and Columbia, but it is the smaller basins draining directly from the coastal mountains to the sea that produce the country's highest unit area runoff. Coastal runoff peaks in the winter months, while the interior runoff peaks in the spring and early summer. With almost no natural or artificial reservoirs, except on the Columbia and Okanagan rivers, flooding remains a threat to communities in the lowlands.

Few Pacific rivers or lakes have yet been degraded by human activity, but pockets of local pollution are associated with the forest products and mining industries and municipal sewage, especially in estuaries. The Fraser's estuary is under intense pressure from urban and industrial development, but the tidal purge has maintained high dissolved oxygen levels and water quality remains high enough to support large stocks of Pacific salmon.

Arctic Drainage

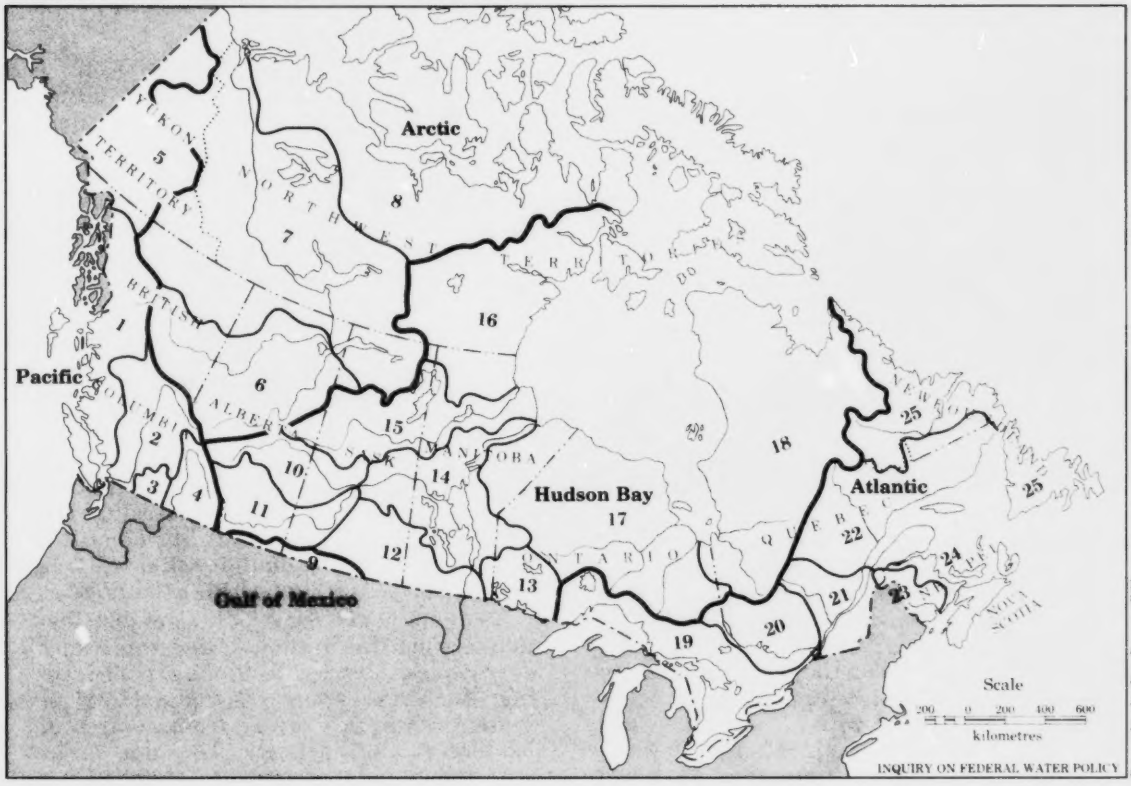
Recent flow estimates for the Arctic mainland and islands are 20,500 m^3/s. Half of this comes from the Mackenzie and its tributaries, which form the largest river system in the Arctic. The Arctic as a whole is characterized by low precipitation, but low temperatures keep evapotranspiration low as well. The region has numerous lakes and massive ice caps and glaciers, all of which contribute to streamflow regulation. The Mackenzie River peaks in the early summer. Its western tributaries have the characteristics of snowmelt rivers in the Rockies and northern prairies: heavier spring runoff, high sediment load, moderately hard waters. Its eastern tributaries have the characteristics of rivers in the Precambrian Shield: clear, softer waters, later and smaller peak flow.

Most lakes begin, geologically, with cold, clear, soft water, low in nutrients and high in oxygen. These characteristics still apply to Great Bear, Great Slave and other lakes in the far north. This region's sparse human populations have had little effect on water quality, which remains high. Some mining, forestry and petroleum-related activities on Mackenzie tributaries draining parts of the prairie provinces have resulted in erosion and local degradation, and abandoned mine tailings are a major concern. The capacity of waters in a cold climate to recover from pollution is much lower than further south where chemical and biological processes are more active.

Gulf of Mexico Drainage

The Milk River, which flows into and out of southern Alberta, and small tributaries of the Missouri that drain from southernmost Saskatchewan, make up the small Canadian drainage destined for the Gulf of Mexico. Because they arise in the grasslands rather than in the Rocky Mountain snowpack, their flows are small and dwindle after their spring peak. These small streams are all subject to international apportion-

Figure 3.10
DRAINAGE REGIONS OF CANADA



OCEAN BASIN REGION		RIVER BASIN REGION	AREA IN 000s km²	POPULATION IN 000s 1981
Pacific	1	Pacific Coastal	352	616
	2	Fraser-Lower Mainland	234	1 722
	3	Okanagan-Similkameen[a]	14	189
	4	Columbia[a]	90	161
	5	Yukon[a]	328	23
Arctic	6	Peace-Athabasca	487	286
	7	Lower Mackenzie	1 300	43
	8	Arctic Coast-Islands	2 025	13
Gulf of Mexico	9	Missouri[a]	26	14
Hudson Bay	10	North Saskatchewan	146	1 084
	11	South Saskatchewan[a]	170	1 282
	12	Assiniboine-Red[a]	190	1 300
	13	Winnipeg[a]	107	77
	14	Lower Saskatchewan-Nelson	363	224
	15	Churchill	298	68
	16	Keewatin	689	5
	17	Northern Ontario	694	157
	18	Northern Quebec	950	109
Atlantic	19	Great Lakes[a]	319	7 579
	20	Ottawa	146	1 270
	21	St. Lawrence[a]	116	5 193
	22	North Shore-Gaspé	403	653
	23	St. John-St. Croix[a]	37	393
	24	Maritime Coastal	114	1 314
	25	Newfoundland-Labrador	376	568
CANADA			9 974	24 343

[a]Canadian portion only; area and population on U.S. side of international basin regions are excluded from totals.

ment. Water quality is largely unimpaired except for some local pollution from agricultural activities.

Hudson Bay Drainage

This huge drainage area extends around Hudson Bay and across the prairies. Total surface runoff is about 30,600 m^3/s, almost 30 percent of the national total. In the west, the larger tributaries of the Saskatchewan-Nelson River system drain from the continental divide; snow and glacier meltwaters sustain flows throughout the growing season on the prairies. On the other hand, streams rising on the prairie grasslands contribute negligibly to runoff. Waters tend to be highly turbid and hard; many groundwater sources are also quite saline. Further northward and eastward, drainage to Hudson Bay rises on the Precambrian Shield, which ensures softer and clearer water.

Rivers and lakes on the Shield are mostly pristine. A few isolated instances of pollution are associated with mining and wood processing; and eutrophication from both natural and human processes remains a common problem in prairie lakes and ponds. More serious problems are emerging as major storage developments release heavy metals like mercury into the Churchill and Nelson rivers and as pesticides are dispersed in agricultural areas.

Atlantic Drainage

This large drainage region is dominated by the Great Lakes-St. Lawrence system, but it includes many other waterways that drain directly to the sea, including the Churchill River of Labrador and the Saint John River of New Brunswick. Total surface runoff averages 29,500 m^3/s from Canadian territory alone. Groundwater is an important resource as well in the lowlands of the Great Lakes-St. Lawrence basin and in the Maritime provinces. In general, water is plentiful throughout the Atlantic region and is well distributed throughout the year.

Pollution is serious only in localized areas in the Maritimes, especially along the coast where industrial operations are concentrated. Inland, along the Lower Great Lakes-St. Lawrence system, waterway degradation is more widespread, resulting from untreated and partially treated industrial and municipal discharges. Toxic substances are particularly serious in Lake Ontario and the St. Lawrence River, especially from waste dumps and landfills, which have contaminated ground and surface waters.

Summary

This chapter emphasizes several characteristics of Canada's water resources that bear on policy.

First, Canada is one of the "have" nations of the world with respect to the availability of water resources. This is a blessing, but also a problem insofar as it has created a perception among Canadians that water is so plentiful that it needs little attention.

Second, the geography of water distribution is such that national, and sometimes even regional, generalizations are misleading. Much of the country is drained by river systems that flow away from centres of population and activity. In some areas where demands are heavy, supplies are meagre. Furthermore, nearly all parts of the country are susceptible in varying degrees to recurring hazards of flood and drought, which do not show up in statistical averages.

Third, the quality of most of Canada's waters is good, being close to natural conditions. Serious pollution is confined to parts of a few lake, river and aquifer systems. But this is misleading because where most of us work and live the waters are more polluted.

Finally, we remain ignorant about some aspects of our water resources. For example, the quantity and quality of groundwater is unknown throughout most of this country. The role of permafrost in the hydrological regime of northern regions is not understood. And we know little about how rivers discharging into the sea affect offshore currents and ecological processes, important as these are to oceanic and atmospheric circulation and to the productivity of marine life.

In the following chapter, we examine the demands on our water resources and the conflicts among uses; these are the problems of water management.

Chapter Four

Water Demands and Conflicts

The issue is much broader than consideration of habitat for fish; more than irrigation or energy development; more than jobs or recreation. It is fundamental to the overall human condition.

BRITISH COLUMBIA WILDLIFE FEDERATION

Our terms of reference call on us to identify available water supplies and future requirements. The preceding chapter provided an overview of the quantity and quality of water resources in the major drainage regions of Canada. In this chapter, we examine the demand for water, both instream and withdrawal uses. We attempt to assess the adequacy of Canadian water resources for present and future use. We also consider water's socioeconomic value. And finally, we review the more serious conflicts among water demands in the regions of Canada.

Withdrawal Uses

Any water use that involves withdrawing water from its source is a withdrawal use. Withdrawals can be measured or estimated with relative confidence.

Some of the water withdrawn eventually returns to surface flows. But some is lost because it has evaporated from the surface, transpired from plants or been removed in agricultural or industrial production. Such water is said to be consumed. Water consumption is considerably more difficult to estimate than water withdrawal.

To gain some appreciation of future water demands we commissioned a study. (1) The resulting projections enable us to compare the demand for water in 1981 with estimates thirty years hence, in the year 2011. We also looked at different possible futures based on varying conditions of economic growth, technological change, use practices and pricing policy. The "high" estimates are based on the assumption that current water-use practices will continue with economic growth. The "low" estimates assume a variety of intensive conservation practices, including the pricing of water.

Municipal

More than 2,500 communities in Canada have water supply systems. Water withdrawals for municipal use totalled 4,263 million cubic metres (m^3) in 1981, of which 15 percent was consumed. Municipalities also withdrew an additional 811 million m^3 for various industrial customers. The distribution of municipal water use tends to correlate with urban population: thus, the Great Lakes-St. Lawrence lowlands account for about 60 percent of this sector's total withdrawal in Canada. (See Table 4.1)

By 2011, total municipal withdrawals could rise to 8,458 million m^3 according to our high estimates, or fall to 3,984 million m^3 if conservation policies are adopted, mainly as a result of assumed increases in the price of municipal water supplies.

Municipal uses require clean water supplies or costly water treatment facilities. Correspondingly, municipal wastewater, if it is returned untreated to the watercourse, can cause serious pollution that impairs the use of the water for other purposes. Two growing problems associated with municipal demands for water are subjects of later chapters: financing of waterworks and sewage treatment facilities are discussed in Chapter 10, while the discharge of municipal wastewaters is examined in Chapter 5.

Rural Residential

Rural residential use includes the water used by rural residences and by communities with a population of less than 1,000. Because of its dispersed nature, rural residences depend primarily on groundwater sources. This sector's total water use in 1981 was relatively insignificant, estimated at 347 million m^3, and consumption was negligible. We have, therefore, not attempted to project this category of use into the future.

Table 4.1
CANADIAN WATER WITHDRAWAL AND CONSUMPTION, 1981
in millions of cubic metres per year

River Basin Region	Withdrawals							
	Municipal*	Rural Residential	Agriculture	Mining	Manufacturing	Thermo Electric	Total Withdrawal	Total Consumption
Pacific Coastal	102	8	—	32	1,632	360	2,134	69
Fraser-Lower Mainland	380	23	258	51	263	—	975	219
Okanagan-Similkameen	29	3	254	19	7	—	312	146
Columbia	36	2	33	15	219	—	305	33
Yukon	5	1	—	10	—	—	16	1
Peace-Athabasca	5	10	17	84	132	4	251	55
Lower Mackenzie	—	1	—	24	1	—	26	2
Arctic Coast-Islands	—	—	—	—	—	—	—	—
Missouri	—	—	46	—	—	110	156	38
North Saskatchewan	132	17	94	55	90	1,018	1,405	154
South Saskatchewan	264	20	1,963	8	121	202	2,578	1,680
Assiniboine-Red	155	21	188	14	24	610	1,012	207
Winnipeg	17	1	1	29	96	—	143	3
Lower Sask.-Nelson	13	4	28	5	72	—	122	25
Churchill	—	1	—	—	—	—	1	—
Keewatin	—	—	—	1	—	—	1	1
Northern Ontario	15	2	—	10	101	—	128	2
Northern Quebec	—	1	—	46	74	—	121	9
Great Lakes	1,313	92	131	75	4,407	14,832	20,850	567
Ottawa	182	15	28	61	352	—	638	77
St. Lawrence	1,207	63	65	3	1,674	308	3,320	343
North Shore-Gaspé	104	8	8	22	301	—	443	39
St. John-St. Croix	111	10	2	—	133	635	892	54
Maritime Coastal	120	34	8	34	421	1,118	1,736	68
Newfoundland-Labrador	68	15	1	50	81	84	299	14
CANADA WITHDRAWALS	**4,263**	**347**	**3,125**	**648**	**10,201**	**19,281**	**37,864**	**—**
CANADA CONSUMPTION	**640**	**—**	**2,412**	**178**	**507**	**168**	**—**	**3,906**

Note:

* Municipalities withdrew an additional 811 m^3 for mining, manufacturing and thermoelectric water uses. These are recorded in the appropriate columns.

Source: Environment Canada, Inland Waters Directorate.

Agricultural

The water withdrawn for irrigation and stock watering is a very small percentage of water used for agriculture. Most comes from precipitation. This sector's withdrawals totalled 3,125 million m^3 in 1981, of which 88 percent was for irrigation. The South Saskatchewan basin contains most of Canada's irrigated land and therefore accounts for most of the withdrawals. Significant withdrawals for irrigation also occur in the Fraser-Lower Mainland and Okanagan basins. The Great Lakes-St. Lawrence region makes the largest withdrawals for stock watering.

In 1981, water consumption in agriculture totalled 2,412 million m^3, or 77 percent of withdrawals, far exceeding that of any other sector. All water used by livestock and almost 75 percent of irrigation water is consumed.

High growth projections indicate that agricultural withdrawals could total 7,113 million m^3 by 2011. But conservation efforts accompanied by modest increases in the price of water could actually result in reductions to withdrawals of 2,800 million m^3 and consumption of 2,200 million m^3.

Agricultural water use raises serious economic questions as well as problems relating to soil protection and water quality. Irrigation helps to stabilize and diversify the prairie economy, but at significant public cost. Subsidized irrigation results in inflated demands for expansion and thus greater pressures on the available water supplies.

Soil salinization in the dry prairie environment and soil erosion may be aggravated by irrigation practices. These are becoming serious problems throughout Canada's agricultural areas. Crop selection, cultivation methods and the application and removal of water from fields all need careful attention, both to maintain the agricultural base and to protect other users, including fish and wildlife, from silted channels, pesticide residues and loss of wetland habitats.

Mineral Extraction

Water is used in mining and processing ore and for cooling drills and other excavating equipment. Large quantities are also used in the petroleum industry for deep well injection and in recovering oil from tar sands.

This sector's withdrawals totalled 648 million m^3 in 1981. But the gross water requirements were 3,440 million m^3, implying that the water was recirculated, on average, some 5.3 times.

Water consumption in the mining sector totalled 178 million m^3 in 1981. Deep-well injection in prairie oil and gas fields accounted for most of this.

Withdrawals are expected to climb to between 1,279 million m^3 and 1,840 million m^3 by the year 2011, with corresponding consumption being between 320 million m^3 and 467 million m^3.

This sector's waste discharges degrade water quality by adding suspended solids, heavy metals, acids and other dissolved substances. Tailing ponds occasionally overflow. Mining can also interfere with the flow of groundwater and thus with users who depend on that source.

Manufacturing

The twenty industrial groups in the manufacturing sector use water for cooling and condensing, processing and steam generation. Their water withdrawals totalled 10,201 million m^3 in 1981, and satisfied a total gross water use of 21,459 million m^3 through recirculation. The paper and allied products industry made the largest withdrawals, followed by the chemicals, iron and steel, and petroleum and coal groups. Industries with small plants are frequently serviced by municipal supplies while large establishments typically develop their own water supply systems.

Water consumption totalled 507 million m^3, or 5 percent of withdrawals in 1981. The Great Lakes-St. Lawrence region accounts for most water used in manufacturing followed by the Pacific coastal region.

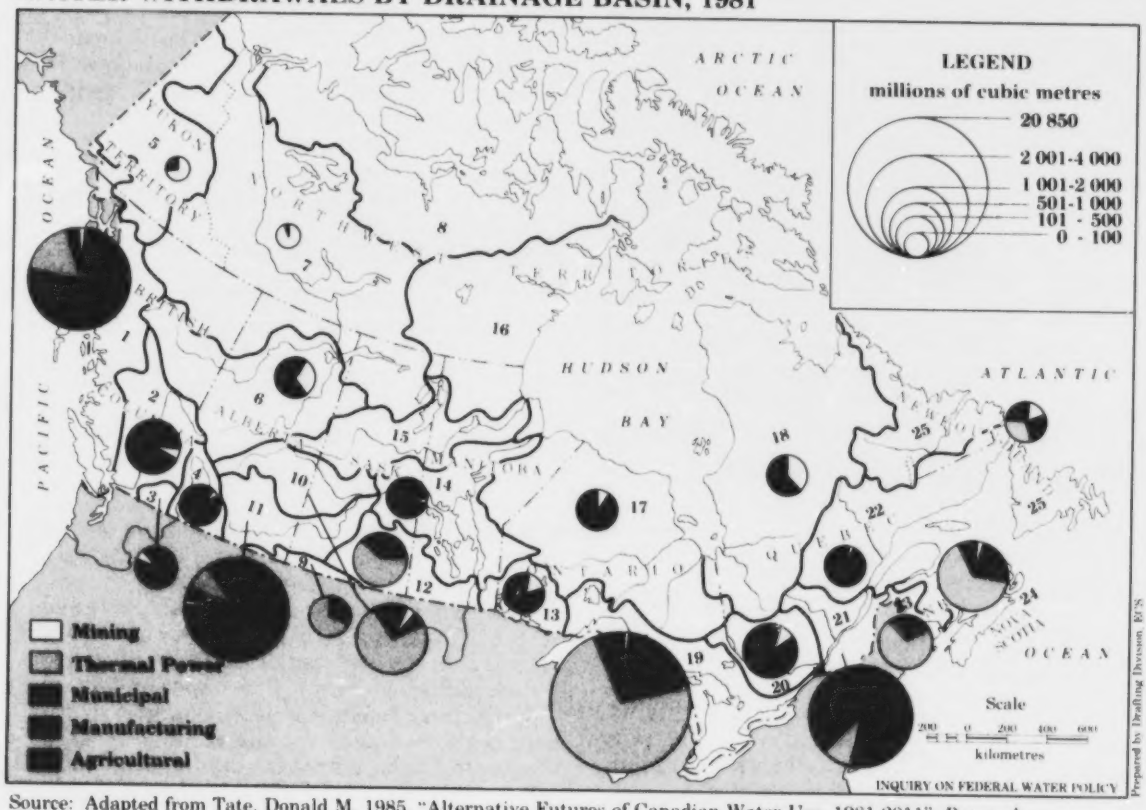
By 2011, this sector's withdrawals are projected to range between 10,500 million m^3 and 23,800 million m^3.

Ninety-five percent of the water used in manufacturing is later discharged as wastewater. The problems caused by industrial pollutants, ranging from biodegradable wastes to substances toxic to fish, wildlife and humans, are discussed in Chapter 5.

Thermoelectricity

In the latter part of the 20th century, energy produced by burning coal, oil and uranium has become increasingly important. Today,

Figure 4.1
WATER WITHDRAWALS BY DRAINAGE BASIN, 1981



Source: Adapted from Tate, Donald M. 1985. "Alternative Futures of Canadian Water Use, 1981-2011". *Research Paper No. 17, Inquiry on Federal Water Policy.*

about 30 percent of Canada's electrical energy comes from these sources.

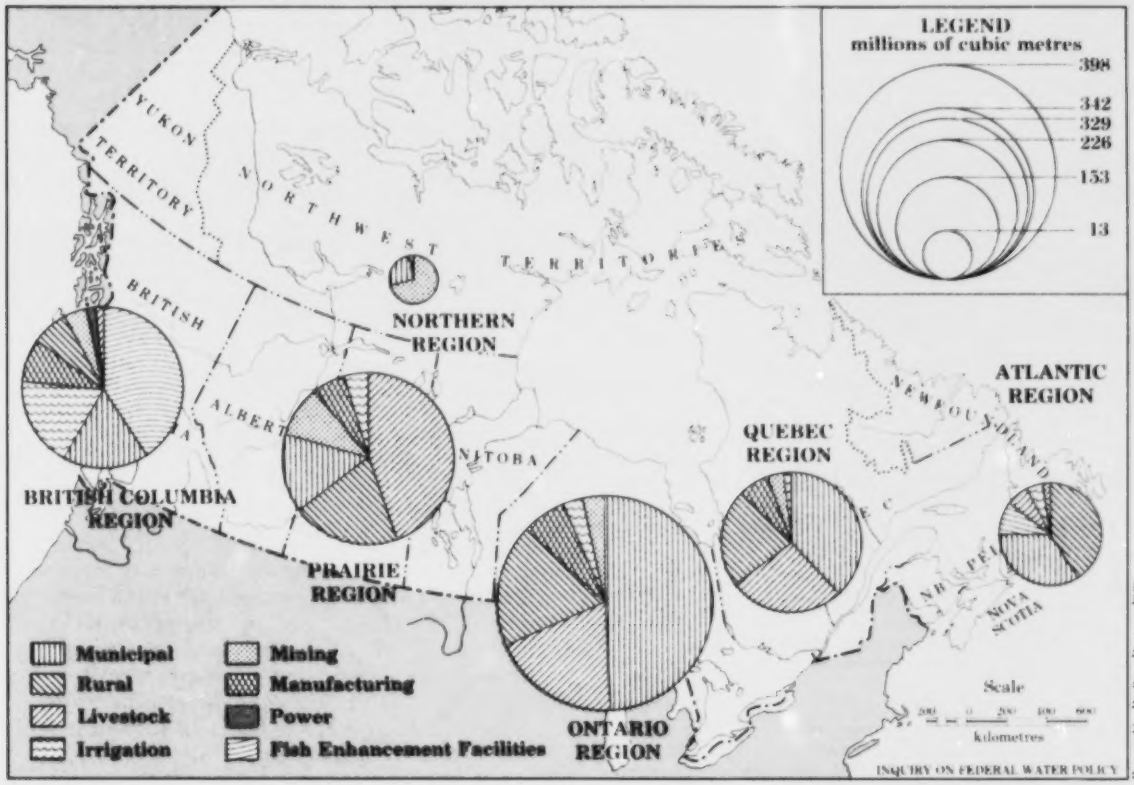
All thermoelectric plants require huge quantities of water for condenser cooling. In 1981, total withdrawal was 19,281 million m^3, the highest of all sectors. Seventy percent of this came from the Great Lakes. Water consumption was less than 1 percent of withdrawal, the smallest proportion of any sector.

Most plants employ a once-through cooling system, where water is returned to the source in essentially the same quantity but at a higher temperature. Plants that recycle water, such as the Sundance station in Alberta, withdraw much less but consume more.

By 2011, thermoelectric power plants are projected to withdraw between 29,200 million m^3 and 43,300 million m^3. This increase will result from a general growth in electricity demands, a higher proportion of electricity generated by thermal means and an increasing emphasis on nuclear plants, which use 60 percent more water than comparable conventional plants.

Thermoelectric power plants have encountered public opposition in recent years. Coal- and oil-fired plants on both sides of the Great Lakes are blamed for much of eastern Canada's acid deposition, and nuclear power plants are feared in some quarters as a threat to public safety. Consequently, some provincial utilities have deferred constructing new plants, adding instead to their hydroelectric power capacity.

Figure 4.2
GROUNDWATER WITHDRAWAL BY REGION, 1981



Source: Adapted from Environment Canada. 1986 (forthcoming). "Groundwater Use in Canada, 1981". *Inland Waters Directorate Scientific Series* by P.J. Hess.

Summary and Trends

In 1981, almost 38 billion m^3 of water were withdrawn from Canadian sources. (See Table 4.1) In fact, 54 billion m^3 were used, but recirculation allowed supplies to be "stretched" some 1.4 times. This represents a remarkable increase of 13 billion m^3 since 1972.(2) The bulk of this is due to increased withdrawal by the thermoelectric sector. This rate of increase will not likely be sustained in the future.

Water consumption totalled almost 4 billion m^3, just over 10 percent of the total intake. This represents an increase of almost 1 billion m^3 since 1972. The largest withdrawal in 1981, was made by the thermoelectric sector, which accounted for slightly more then half of the total. The largest consumer, however, was agriculture.

Figure 4.1 shows water withdrawals by major use in each drainage basin. Only 4 percent of withdrawals are from groundwater, which is the source of domestic water for about 25 percent of the population. As shown in Figure 4.2, groundwater is important mainly for municipal supplies, rural use and livestock watering.

Instream Uses

Instream uses take place largely in or on the river, lake or wetland. Hydroelectric power plants, ships, fish, wildlife and many types of recreation all have instream needs. Unlike withdrawal uses, the amount of water used for these purposes is difficult to quantify.

Hydroelectricity

Hydroelectric power production depends on the flow available in a river and the height from which the water falls. Many hydro developments entail damming rivers and creating large storage reservoirs, so that natural variations in flow can be regulated according to the need for electric power. Others operate on natural flows or upstream storage.

Table 4.2
HYDROELECTRIC POWER CAPACITY IN CANADA, JANUARY 1984

Provinces	Developed (MW)	Technically Developable Potential (MW)
Northwest Territories	47	6,000
Yukon Territory	78	10,430
British Columbia	10,842	27,119
Alberta	734	12,425
Saskatchewan	575	1,703
Manitoba	3,641	6,100
Ontario	7,126	6,164
Quebec	25,133	31,367
New Brunswick	901	556
Nova Scotia	368*	93
Prince Edward Island	—	—
Newfoundland	6,301	6,507
TOTAL	**55,746**	**108,464**

Note:
* Excludes 18 MW of tidal power at Annapolis Royal.

Source: Energy, Mines and Resources Canada, Electrical Energy Branch.

Table 4.2 shows existing generating capacities and current estimates of power generating potential. By 1984, 55,746 megawatts (MW) of hydroelectric capacity had been installed, and another 108,464 MW of potential capacity remained. Remaining large-scale hydro resources are mainly in British Columbia, Yukon, the Northwest Territories, Quebec and Labrador.

Virtually none of the water passing through hydroelectric turbines is consumed, but significant amounts evaporate from storage reservoirs. Concerns focus on the loss of land and land-based resources, loss of wildlife and fish habitat, the conversion of wild rivers into regulated water bodies, the barriers dams impose on fish, and the change in downstream river flow regimes. Erosion, sedimentation and thermal stratification are also directly or indirectly associated with these developments.

Navigation

Water still provides the most economical means of transporting the bulky raw materials of Canada's important exports: wheat, pulp and paper, lumber, and minerals. Most commercial inland shipping moves through the St. Lawrence Seaway. But communities and industries in the north depend heavily on the Mackenzie River for bulk shipping.

In other areas, commercial navigation occurs in estuaries and river mouths, especially along the Pacific and Atlantic coasts and at Churchill. But in many parts of Canada waterways formerly used for commercial navigation now provide recreational opportunities.

Navigation sometimes conflicts with other water uses. The high water levels needed for navigation cause erosion and threaten beaches; dredging to maintain depth degrades water quality; pollution from shipping, especially spills of hazardous material, threatens municipal water supplies and recreation; ice-breaking operations threaten fish and wildlife.

Waste Disposal

When Canada had a smaller population, untreated sewage and industrial effluent could be assimilated by receiving waters. But discharging wastes into water has become less and less feasible for at least two reasons. First, with population and industrial growth, more wastes are being gener-

ated and discharged, often exceeding the water's assimilative capacity. Second, industrial wastes, especially, often include persistent and toxic contaminants that cannot be assimilated in the usual sense, but remain in the environment. The challenges imposed by using water for waste disposal are discussed in detail in the following chapter.

Fish and Wildlife

Natural water bodies provide the essential habitat for most fish and wildlife. And each species has its own habitat requirements. Salmon, for example, need moderate flows; granular substrate; clear, cool water; and deep pools. Perch, in contrast, can tolerate warm temperatures, moderate to high turbidity, some fine sediments and low flows.

Many wildlife species are extremely sensitive to changes imposed by dams, diversions, channel modifications and wetland drainage as well as to various toxic and oxygen-depleting pollutants.

Waterfowl habitat is seriously threatened by the drainage of wetlands for agricultural and other purposes. We do not know how much Canadian wetland has been converted, but Table 4.3 summarizes the information available for western Canada.

Table 4.3
QUANTITATIVE WETLAND CONVERSION STUDIES IN WESTERN CANADA

Region and Authors	Study Area Size (km^2)	Era	Net Wetland Change Results
Aspen Parkland, (Alberta) (Schick, 1972)	699	1900-1970	61% loss (area)
Battle River Basin (Alberta) (Ritter, 1979, 1980)	301	1800-1978	9% loss (area)
South Saskatchewan River Basin (Alberta) (Schmitt, 1980)	45	1800-1979	21% loss (area)
Southern Saskatchewan (Sask.) (Millar, 1981)	82	1950-1980	27% permanent impact (no. of sites)
Black Soil Zone (Alberta, Saskatchewan, Manitoba) (Goodman and Pryor, 1972)	21	1940-1970	13% loss (area)
Newdale Plain (Manitoba) (Adams and Gentle, 1978)	248	1964-1974	17% affected 7% eradicated
Valley River Watershed (Manitoba) (Pokrant and Gaboury, 1983)	1,786	1948-1981	37% loss (area)
Minnedosa Pothole Region (Kiel et al, 1972)	131	1928-1964	27% loss (area)
Minnedosa Pothole Region (Rakowski et al, 1974)	131	1964-1974	40% loss (area)
Minnedosa Pothole Region (Rakowski and Chabot, 1983)	131	1974-1982	41% loss (area)
Southwestern Fraser Delta (Pilon and Kerr, 1984)	524	1967-1982	27% converted 11% loss (area)

Source: Rubec, C.D.A. and Paul C. Rump. 1984. "Prime Wetland Land Use Monitoring Activities and Needs in Southern Canada." Paper prepared for the 3rd Annual Western Provincial Conference on Rationalization of Water and Soil Research and Management. November 20-22. Winnipeg.

The fur trade and the fishing industry are Canada's two oldest economic activities. Although they now contribute only modestly to the gross national product, they remain the major source of income in many northern and coastal areas. As well, fish and wildlife are valued as food, as a part of a way of life, and as recreational and aesthetic resources. These values are more difficult to measure, but they are often important considerations in water management.

Recreation

Water-based recreation does not usually involve withdrawing or consuming water, but a variety of recreational activities are sensitive to site features such as surface area, depth, rate of flow, quality, temperature and accessibility.

Swimming is the most popular water-based form of recreation in Canada; 44 percent of Canadians swim for recreation. This exceeds the participation in all forms of boating. (3) In 1980, well over 6 million people purchased fishing licences and about 2.5 million held hunting licences.

Some Canadians seek the remoteness of northern lakes and parks but many urban dwellers rely on reservoirs and water bodies that have many competing and conflicting users.

Table 4.4
MONTANA METHOD BASE FLOWS

Degree of Habitat Protection	Percentage of Average Annual Natural Flow	
	(October to March)	(April to September)
Optimum	60-100	60-100
Outstanding	40	60
Excellent	30	50
Good	20	40
Fair or Degrading	10	30
Poor or Minimum	10	10
Severe Degradation	less than 10	less than 10

Source: Adapted from Tennant, Donald. 1976. "Instream Flow Regimes for Fish, Wildlife, Recreation and Related Resources." *Fisheries* No. 1.

Measuring Instream Requirements

No satisfactory method exists for quantitatively assessing the water requirements for all these instream uses. But engineers and others have developed rules of thumb for this purpose. For example, some use a rule based on a percentage of average flow: 60 percent of average flow is judged to provide excellent habitat for fish and wildlife, and 30 percent good habitat.

The "Montana method" is another way to estimate instream needs. (4) Flow is expressed as a percentage of the average annual natural flow required for different degrees of habitat protection during October to March and April to September. (See Table 4.4)

Both these methods are very crude. They fail to take into account short-term flow fluctuations, tributary and local stream reaches, individual species requirements, and other variables like water quality, temperature, migration patterns and so on.

Nevertheless, by the Montana method of estimating the flow requirements for fish habitat protection, few rivers in Canada have been seriously impaired by withdrawals or flow alterations. Exceptions are found in rivers of the southern prairies, where flows often fall short of the requirements for good fish habitat.

Economic Values

Since water is rarely traded in competitive markets, its contribution to our economy can only be estimated indirectly. Table 4.5 shows estimates of the amount users would be willing to pay for the use of water for various purposes over and above the costs of supplying it. (5)

These calculations are extremely rough, and include only some uses. Purely economic benefits in such forms as commercial fisheries and navigation are excluded, as are most recreational uses. Nor can we measure in conventional economic terms the aesthetic value we derive from water, its role in the lifestyles of native people, or its contribution to our culture and national identity. While these values defy quantification, they are undoubtedly considerable, and may well exceed the estimated values of between $7.5 and $23 billion per year in Table 4.5.

While estimates such as these help to demonstrate the economic contribution of our water resources, they do not indicate how water should be allocated in any particular time and place. To determine that we need to know the water's marginal value, that is, the value generated by the last small increment of water. Usually, the more water used in any particular use, the lower its marginal value. This explains how water can be very valuable for some purpose, like human consumption, but once the urgent need is met the value of an additional increment of supply may be very low.

These estimates also disguise the fact that these values are generated by a small fraction of Canada's water resources. The uses listed in Table 4.5 are heavily concentrated in a few localities on relatively few waterways. Where these demands are concentrated, the value of water is great. But most of Canada's waters are used for few, if any, of these purposes. Thus, the economic value of water in Canada varies widely.

Table 4.5
ESTIMATES OF THE ECONOMIC VALUE OF WATER, CANADA

Selected Uses	Average Net Value[a] Low ($/000 m³)	Average Net Value[a] High ($/000 m³)	Total Net Value[a] Low (millions of $)	Total Net Value[a] High (millions of $)
Municipal	100	2,430	288	6,968
Irrigation	0	36	0	109
Thermal Power	9	9	169	169
Industrial Uses				
Paper	87	87	251	251
Chemical	76	76	217	217
Primary Metals	16	43	44	118
Petroleum	19	19	10	10
Food & Beverages	30	124	13	53
Sub-Total Withdrawal			**993**	**7,896**
Hydroelectricity			4,226	6,553
Waste Assimilation[b]	1	4	645	2,272
Sports Fishing[c]	20	74	1,677	6,309
Sub-Total Instream			**6,459**	**15,134**
TOTAL			**7,541**	**23,030**

Note:
[a] Values estimated in terms of the maximum amount users would be willing to pay for water in the indicated uses.
[b] Willingness to pay in $/kg of BOD discharged.
[c] Willingness to pay in $/fishing day.

Source: Adapted from Muller, R. Andrew. 1985. "The Socioeconomic Value of Water in Canada". *Research Paper No. 5, Inquiry on Federal Water Policy*. Ottawa.

Table 4.6
CANADIAN WATER SUPPLIES AND DEMANDS
millions of cubic metres per year

River Basin Region	Current Reliable Annual Flows[a]	1981 Withdrawals[b]	1981 Consumption	2011 Withdrawals Low Estimate	2011 Withdrawals High Estimate
Pacific Coastal	396,400	2,134	69	2,025	4,398
Fraser-Lower Mainland	96,000[c]	975	219	974	2,047
Okanagan-Similkameen	971[d]	312	146	300	681
Columbia	51,850[d]	305	33	292	654
Yukon	56,950[d]	16	1	33	50
Peace-Athabasca	58,720	251	155	304	585
Lower Mackenzie	192,800[e]	26	2	46	68
Arctic Coast-Islands	186,670	—	—	—	—
Missouri	105[d]	156	38	215	365
North Saskatchewan	5,046	1,405	154	2,041	3,267
South Saskatchewan	4,636[cd]	2,578	1,680	2,601	6,058
Assiniboine-Red	497[d]	1,012	207	1,354	2,284
Winnipeg	12,040[cd]	143	3	152	312
Lower Sask.-Nelson	34,937[de]	122	25	132	310
Churchill	10,190[c]	1	—	—	—
Keewatin	92,870	1	1	—	—
Northern Ontario	117,700[c]	128	2	120	269
Northern Quebec	404,300[c]	121	9	143	268
Great Lakes	75,780[d]	20,850	567	28,471	46,655
Ottawa	43,840	638	77	626	1,304
St. Lawrence	47,430[de]	3,320	343	3,317	6,774
North Shore-Gaspé	203,000	443	39	394	876
St. John-St. Croix	15,990[d]	892	54	1,164	1,786
Maritime Coastal	65,564	1,736	68	2,238	3,565
Newfoundland-Labrador	217,900	299	14	344	542
CANADA	**2,392,186**	**37,864**	**3,906**	**47,738**	**84,039**

Note:
[a] Flow equalled or exceeded, on average, in 19 out of 20 years.
[b] For municipal, rural residential, industrial, mining, agricultural, thermoelectric power uses. Rural residential uses are excluded from 2011 forecasts.
[c] Excludes flow transferred into neighboring basin region.
[d] Excludes inflow from United States portion of basin region.
[e] Excludes inflow from upper basin region.

Source: Flow data from Inland Waters Directorate, Environment Canada. Data on demands from Tate, Donald M. 1985. "Alternative Forecasts of Canadian Water Uses, 1981-2011". *Research Paper No. 17, Inquiry on Federal Water Policy.*

The Balance of Water Supply and Demand

Table 4.6 compares estimates of the supply and demand for water in 1981 in each major river basin. The supply is expressed in terms of reliable annual flows, and demand is expressed in terms of withdrawals and consumption. The table also shows our low and high projections of withdrawals in the year 2011.

Clearly, in Canada as a whole, the balance between renewable supplies and withdrawal demands is extremely favorable. In 1981, withdrawals were less than 2 percent of reliable annual river flows; and by 2011, they are expected to increase only to between 2.5 and 4 percent, depending on future economic, technological and policy variables.

The only exceptions to this favourable balance are found in the southernmost parts of the prairie provinces, specifically, in the Assiniboine-Red, Missouri and South Saskatchewan basins.

However, the figures in this table must be interpreted cautiously, for several reasons.

First, the balance of water supply and demand for large basins or groups of basins as in Table 4.6, tend to mask the much wider variations among individual streams and tributaries. Similarly, measures of annual flows and uses disguise significant seasonal variations. Even in the midst of general water abundance, shortages may be experienced at certain times or locations.

Second, water quality information has not been incorporated into the supply picture. This is a significant shortcoming because pollution has impaired or rendered virtually unuseable large quantities of water for some purposes, particularly where users are concentrated.

Third, water supply may be affected by long-term climatic changes that could alter patterns of precipitation and evapotranspiration by the year 2011. Today's models cannot yet tell us what tomorrow's climate and water supply will be. (6)

Fourth, for reasons we have mentioned, we have no reliable measure of instream water requirements. So even though instream needs may be as important to Canadians as withdrawal uses, we are unable to quantify them and incorporate them into our estimates of demands.

Finally, we have projected demands only in terms of withdrawals, while the ultimate capacity of rivers to meet demands also depends on consumption. As we have seen, consumption tends to be only a fraction of withdrawals, and to this extent our projections of pressures on available supplies are exaggerated.

Our estimates of the balance between water supplies and demand are therefore very rough, but they are more detailed than has hitherto been available. This indicates our present limited knowledge about water resources and their uses in Canada, a subject to which we return in a later chapter.

Regional Demands and Conflicts

Not surprisingly, increasing pressure on Canada's water resources has led to competition and conflict. The nature and intensity of conflict varies significantly across the country. We review here the more important water use patterns and conflicts for each of Canada's five ocean drainage regions, described in Chapter 3.

Pacific

Economic activity in the Pacific region is led by primary resource industries: forestry, mining and related processing. Agriculture is important in the southern valleys of British Columbia's interior and on the Lower Mainland. Hydropower production is important for the domestic market and for export. Coastal rivers support major salmon stocks.

Most conflicts in this region involve hydroelectric power or fisheries, or both. Hydro dams have inundated arable land in interior valleys, especially the Columbia, Kootenay and Peace, and threaten to interfere with salmon runs on the Stikine and Yukon rivers. Logging and mining and associated silting and pollution of river channels and estuaries conflict with recreation, fish and wildlife. Irrigation in dry interior valleys like the Okanagan sometimes reduces late season tributary flows needed for fish propagation.

Arctic

Other than small quantities of water used for mining activities, instream uses dominate in Arctic watersheds. These include fish, wildlife, recreation and summer navigation on the Mackenzie River.

Most conflicts over Arctic water resources are potential. Northern residents are primarily concerned about potential hydro and interbasin transfer projects, which could severely disrupt the northern water regime. They are also concerned about water quality deterioration from oil and gas development and from abandoned metal mines.

Gulf of Mexico

This region's area, population and water resources within Canada are all small. Total water withdrawals are divided among agriculture and thermoelectric power production. Opportunity for further development is limited by apportionment arrangements with the United States.

Hudson Bay

Water use patterns differ significantly between the western and eastern portions of this region.

The major conflicts in the Hudson Bay drainage area involve prairie irrigation and hydro development. Irrigation consumption reduces the water available for downstream hydropower generation in the Saskatchewan-Nelson systems and for waste dilution and other instream uses. Hydropower development and interbasin transfers conflict with instream water uses and the traditional lifestyle of northern native communities.

Other conflicts result from the draining of wetlands for agriculture, which reduces waterfowl habitat; the use of agricultural pesticides; oil-recovery operations which pollute surface and groundwater resources; and mining wastes and spills, which have degraded water quality for fish and community supplies.

Atlantic

Water use conflicts are numerous and serious in the Atlantic drainage region, particularly in the Great Lakes-St. Lawrence basin. Conflicts arise between navigation and power interests, on the one hand, and shore property owners on the other: the former prefer high water levels, while shore property owners prefer lower levels to minimize erosion and to protect beaches and dock facilities. Other conflicts involve community water supplies, which are threatened by contamination from pesticides and chemical waste dumps; and fishing, which is threatened by lake overenrichment and acid deposition.

Summary

Our survey of water demands and supplies has led us to some general conclusions.

First, Canadians withdraw but a tiny fraction of their immense water resource from its natural setting, less than 2 percent, and consume much less than 1 percent. Instream resource needs are therefore generally protected by the overwhelming proportion of water left in our lakes, rivers and aquifers. These overall ratios are not likely to change very much in the next three decades.

Second, national trends tend to disguise important regional and local exceptions. The drainage basins of the southern prairies are already experiencing difficulties with heavy consumptive uses in drought years; measures may have to be taken to store, transfer or reallocate water among competing demands. In other regions instream needs may also exceed the water available in individual tributary watersheds, such as those tributary to the Great Lakes. It is little comfort for a farmer in southern Saskatchewan confronted with a drought, or a resident of Nova Scotia contending with a contaminated aquifer, to know that abundant and pristine waters are available in some other river basin.

Third, with few exceptions, Canada's most serious water use problems are not related to inadequate supply at all, but to degraded water quality and to disrupted flow regimes. No one knows this better than our native people who have watched their traditional pursuits on water deteriorate from pollution of all kinds and from storage and diversion projects that manipulate lake levels and river flows. There is hardly a major drainage system anywhere south of the Arctic which has not been affected by these pressures.

Finally, we live in a period of growing uncertainty. With increasing human influence on climate, land use and water distribution, past experience may not provide a reliable guide for future needs.

We have some opportunity to define the kind of future we want by selecting policies that will ensure safe and sustainable water for Canadians.

Chapter Five

Pressures on Water Quality

The reality is that Canada, though a small country, pollutes to its ability.

CANADIAN COALITION ON ACID RAIN

Protecting the quality of our natural environment has emerged as a major issue of our time. Since the mid 1960s a broadly based environmental movement has been emerging that is a product of our anxieties over the impact of modern urban and industrial societies on natural systems.

The environmental movement has gathered remarkable social and political force and has motivated a profusion of protective laws and regulations. Governments at all levels have had to create special departments or ministries to support environmental protection while municipalities and industries have had to substantially alter and improve their waste treatment and management practices. As a result, the public at large has been awakened to the necessity of protecting natural resources and its surrounding environment in the interests of long-term economic prosperity as well as the quality of life.

Much of this concern for the environment is focused on water since, from time in memoriam, it has provided such a convenient sink to the increasing discharges of our people and their industry. However, modern society also needs clean water for human consumption, many economic activities and other uses such as recreation. Indeed, water is such an intimate and necessary element in our daily lives that degradation of its quality causes immediate conflicts with other uses and requires our immediate attention.

In this chapter we review, in broad terms, the pressures on water quality in Canada. These are the problems that pollution control policies, described in subsequent chapters, must cope with.

Pollutants

We begin this review with a brief description of pollutants and their prevalence in Canada.

Conventional Pollutants

Substances That Increase Oxygen Demand. Oxygen is an essential element to aquatic life. Its presence in water is due to its absorption at the interface between atmosphere and water and to the photosynthesis of plants in the water.

Wastes generated by natural sources or by human activities impose a burden on the natural content of oxygen in our waters. Bacteria, which are naturally present in waterways, digest or decompose organic substances to obtain energy and material for cell growth. They consume oxygen in the process. The amount of oxygen used is called the biochemical oxygen demand (BOD), and is considered to be a measure of the organic content of wastewaters.

Although a certain level of organic material is naturally present in all freshwater, it can be significantly increased by the organic discharges of wastewaters, which can completely deplete oxygen resources and cause sensitive species in the waterways to die or function abnormally.

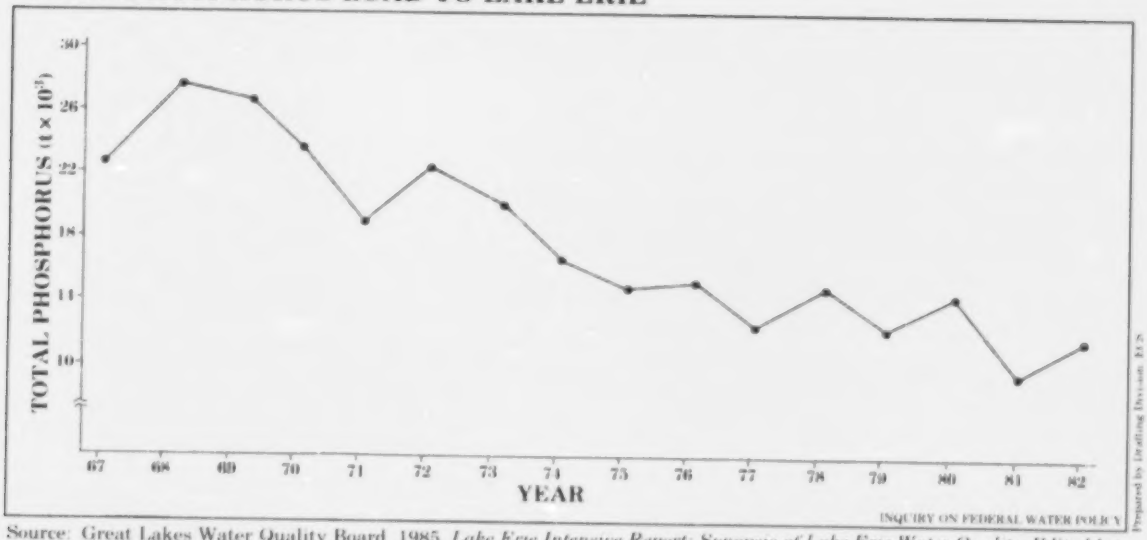
Solids. All waters contain solids in either floating, settling colloidal or dissolved form. These solids can be organic (oxygen consuming) or inorganic; they can derive from man made sources or be naturally occurring.

Most organic solids are eventually decomposed into elemental form and assimilated into new plant growth. Inorganic solids can also be absorbed by living organisms under certain conditions, but more frequently they find their way to the bottom of streams, lakes or reservoirs where they interfere with fish habitat, plant growth and sometimes navigation.

Solids may alter the quality of water in other ways by increasing turbidity, limiting light penetration and reducing the energy available to aquatic ecosystems. Floating solids may contain considerable amounts of fats and oils, which tend to befoul shorelines and recreational areas.

This type of pollution originates primar-

Figure 5.1
TOTAL PHOSPHORUS LOAD TO LAKE ERIE



Source: Great Lakes Water Quality Board. 1985. *Lake Erie Intensive Report: Synopsis of Lake Erie Water Quality*. Edited by D.E. Rathke, C.J. Edwards. Report to the International Joint Commission. Ottawa.

ily from natural sources, but human activities contribute significantly in certain locations.

Nutrients. High concentrations of phosphorus and nitrogen can lead to eutrophication of lakes and reservoirs, characterized by excessive growth of algae and other aquatic plants. This process occurs naturally, but can be accelerated by high loadings of phosphorus from such sources as municipal effluent and agricultural runoff. In addition to causing taste, odor and aesthetic problems, algae lower dissolved oxygen levels when they die and decay.

Such conditions developed in Lake Erie during the late 1960s, prompting a concerted effort on the part of Ontario, the eight states bordering the lakes, and the Canadian and U.S. federal governments to control phosphorus discharges from treated municipal wastewater effluents. (1) Important progress has been made in lowering the phosphorus load, but Lake Erie is still considered to be eutrophic. (See Figure 5.1)

Figure 5.2 shows the levels of total phosphorus in some Canadian river basins based on recent sampling. Since only a small portion of Canada is covered by the national water quality monitoring network, the data are incomplete.

The high phosphorus values recorded in northern British Columbia, Yukon and the Northwest Territories result primarily from naturally occurring mineral apatite phosphorus which does not contribute to eutrophication. However, in some areas, such as the Okanagan Valley in southern British Columbia, the southern part of the prairies and the valley of the St. Lawrence (from Cornwall to Québec City), municipal and agricultural runoffs account for a significant portion of the total load.

The eutrophication of some lakes and rivers is aggravated by Eurasian milfoil, a weed accidentally imported from Europe and exceptionally difficult to control. It requires little fertilization and grows at an astonishing rate. It has already caused millions of dollars in damage to recreational interests in Quebec, Ontario and British Columbia.

Microorganisms. Historically, water has played a significant role in the transmission of human disease. Hence, microorganisms, especially bacteria and viruses, were the first pollutants to attract attention. Drinking water purification and bacteriological surveillance programs have resulted in a dramatic decrease in water-related illness in Canada. Nonetheless, waterborne disease outbreaks occur occasionally, highlighting the importance of maintaining strict supervision and control over the quality of public water supplies.

Pollution by bacteria and other microorganisms continues to be a problem in waters used for recreation. Beach closures are still common in many parts of the country.

Other pollutants. Other organic pollutants include major ions, oil and grease, acid and alkalis. Major ions such as calcium, sodium and carbonates are frequently present in sufficient concentrations to create hardness and taste problems.

Oil and grease are oxygen demanding and aesthetically unpleasant. In addition, rather than mixing with water, they form a thin layer over it and thus inhibit oxygen absorption.

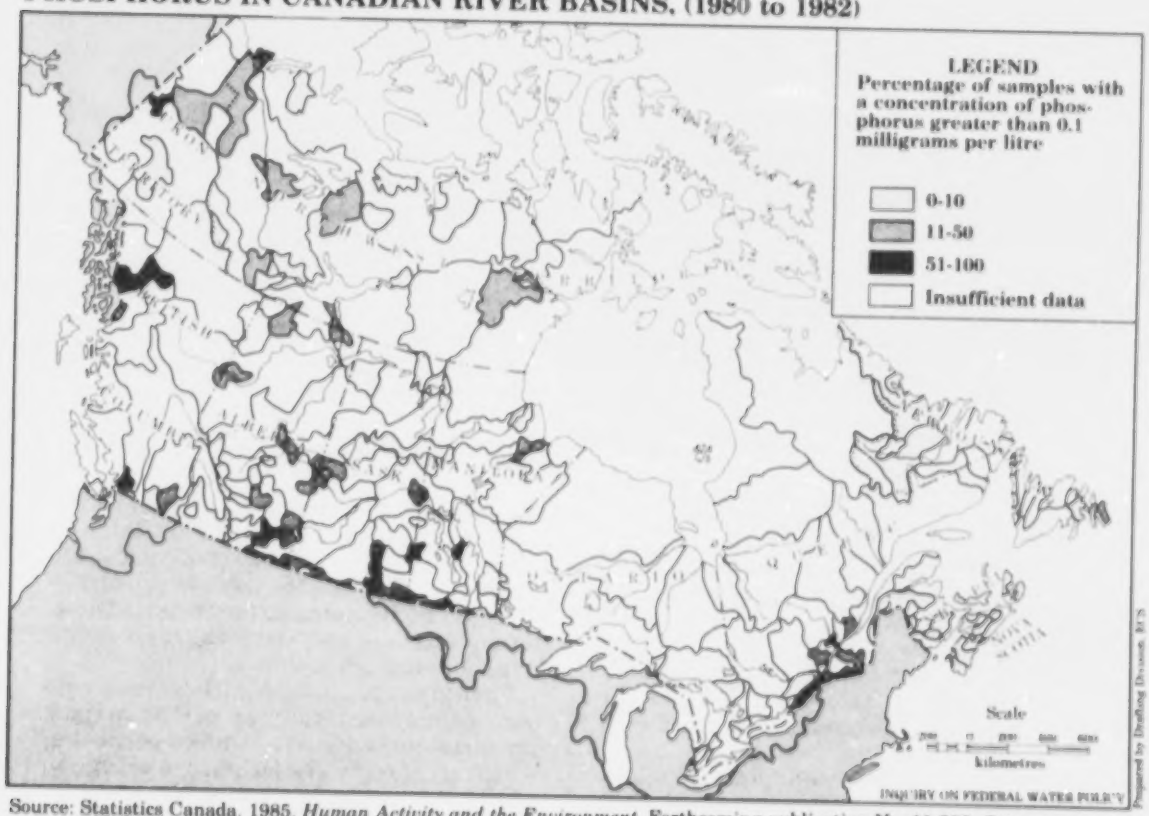
Water that is too alkaline or too acidic cannot support aquatic life. In addition, more acidic water can contain higher concentrations of heavy metals such as arsenic, mercury and copper.

Toxic Substances

A toxic substance can be defined as one that poses a threat to natural ecosystems or to human health or well being. (2) Some toxic substances occur naturally, but most are synthetic. Although not all chemicals are toxic, more than 4 million are registered and more than 32,000 are being used in Canada today. The growing use of chemicals is of concern.

Some toxic substances are "persistent", meaning they resist biological or chemical transformation. Others are "bioaccumulative", that is, they accumulate in living organisms, generally in their fatty tissues or organs. Some are both bioaccumulative and persistent. Toxic substances with these properties cause special concern and some, like PCBs, PBBs and PCTs have been strictly regulated.

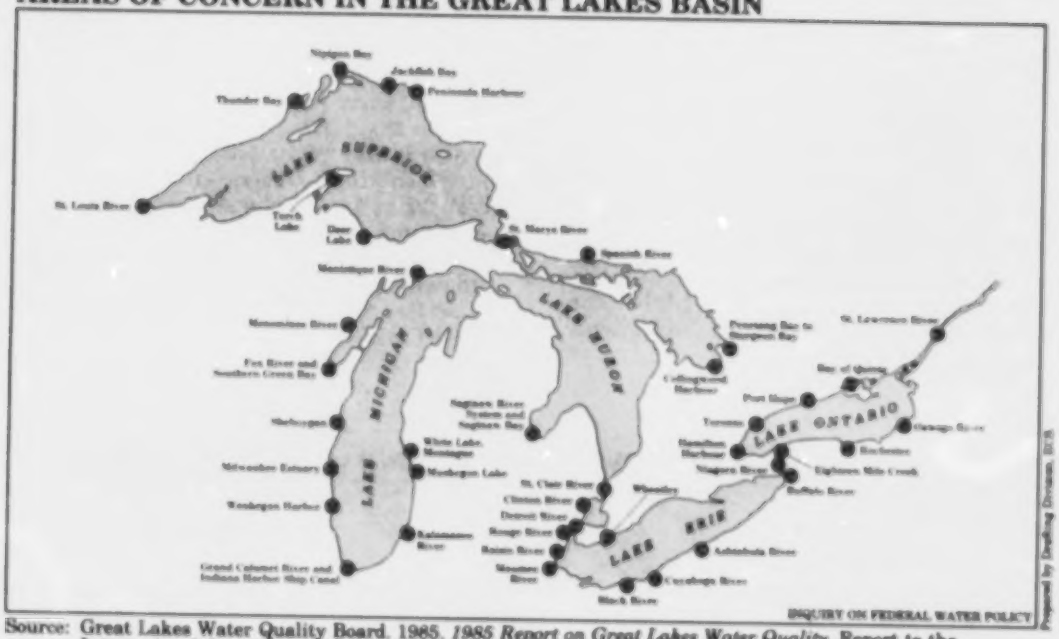
Figure 5.2
PHOSPHORUS IN CANADIAN RIVER BASINS, (1980 to 1982)



Source: Statistics Canada. 1985. *Human Activity and the Environment*. Forthcoming publication No. 11-509, Ottawa.

Note: Due to the heterogeneous nature of drainage basins, no standard exists for phosphorus concentrations. However, concentrations above 0.1 mg/L of total phosphorus in flowing waters increase the probability of the accelerated growth of algae.

Figure 5.3
AREAS OF CONCERN IN THE GREAT LAKES BASIN



Source: Great Lakes Water Quality Board. 1985. *1985 Report on Great Lakes Water Quality*. Report to the International Joint Commission, Ottawa.

The effects of toxic substances vary widely depending on quantities absorbed, conditions and duration of exposure, susceptibility of exposed organisms and other factors. Sometimes the levels present do not significantly affect an organism's health, but might impart unpleasant flavors. This can destroy a commercial or recreational fishing industry.

The latest studies on water quality in the Great Lakes revealed that they contain approximately 800 toxic organic substances. It is not known how many are present in sufficient concentrations to pose a threat to human health or to ecosystems, but the sheer number raises considerable concern. (See Figure 5.3)

Pesticides have become a special problem. They easily enter the food chain and some accumulate in the tissues of certain species. Once they enter the environment, they are hard to eliminate, and their effects can be felt long after their use has been discontinued. Nevertheless, pesticides have resulted in increased agricultural production and better control of disease-carrying insects and will be difficult to replace.

Although pesticides have received more attention than other toxic substances, toxicological and environmental data are still meagre. Little information is available on pesticide levels in streams, sediments and biota, although studies have been intensified. (3) The degradation products and long-term effects are also receiving more attention, but progress is slow.

Thousands of other potentially toxic substances are used daily as raw materials, products and additives. Unlike pesticides, which are specifically designed to be toxic to some target organisms, the risks posed by some organic compounds have gone unrecognized until recently.

The identification of toxic substances in our aquatic environment, the growing number of new chemicals being produced, and an incomplete understanding of their behavior and effects continue to generate concern about the ability of chemical producers, users and governments to ensure adequate water quality and the public's health and safety. The potential adverse effects on human health from extended exposure to toxic contaminants in drinking water, air, food and soil has emerged as a major problem of environmental protection.

Atmospheric Pollutants

Another new environmental concern is the effect of atmospheric pollutants on water quality. Research indicates that a significant number of contaminants cycle through the atmospheric and aquatic systems, thereby linking air and water pollution causing such phenomenon as acid rain.

When sulphur and nitrogen oxides come into contact with atmospheric moisture, some are converted into sulphuric and nitric acids, which ultimately fall to earth as acid rain or snow. (Pollutants also fall to earth as dry deposition and are converted to acids upon contact with water.)

The most significant sources of sulphur oxides found in Canada are the nonferrous smelters in Manitoba, Ontario and Quebec and the coal-burning electrical generating plants in Ontario and the northeastern United States.

Emissions of nitrogen oxides are concentrated in the eastern part of the continent. About half of these come from vehicle exhausts, a quarter from thermal power plants and the remainder from industrial, commercial and residential fuel combustion. (4)

Studies undertaken by Fisheries and Oceans Canada indicate that 400,000 lakes in Eastern Canada located in areas sensitive to acid deposition are receiving more sulphur than is considered normal (10 kilograms of wet sulfate per hectare per year). Approximately 90,000 of these lakes are receiving twice that much. (See Figure 5.4)

The resulting fish loss has adverse effects on tourism and recreation. Acidification may also threaten agriculture, forestry and drinking water through metal poisoning.

Atmospheric transport of various toxic organic substances and heavy metals also threaten aquatic systems. While public concern has not focused on this issue, an estimated 10 to 15 percent of the phosphorus loading in the Great Lakes in the late 1970s resulted from atmospheric transport. More recently, measurable amounts of pesticide residues have been observed in waters hitherto thought to be pristine, such as the lakes and streams on Ellesmere Island in the Arctic and the headwaters of the Rocky Mountains.

Radioactive Materials

Radioactive substances can be toxic in a similar way to nonradioactive heavy metals. In addition, radiation can cause mutations, cancer, deformations and other harmful effects in organisms and their offspring.

Radioactive substances such as uranium occur naturally, and a low level of radioactivity is present in land and water. But industrial activities in the twentieth century have increased this level. Activities related to the mining and processing of radioactive substances and their use in power generation are sources of radiation pollution, but minor sources so far. However, the storage of nuclear wastes poses a problem and a challenge for the future.

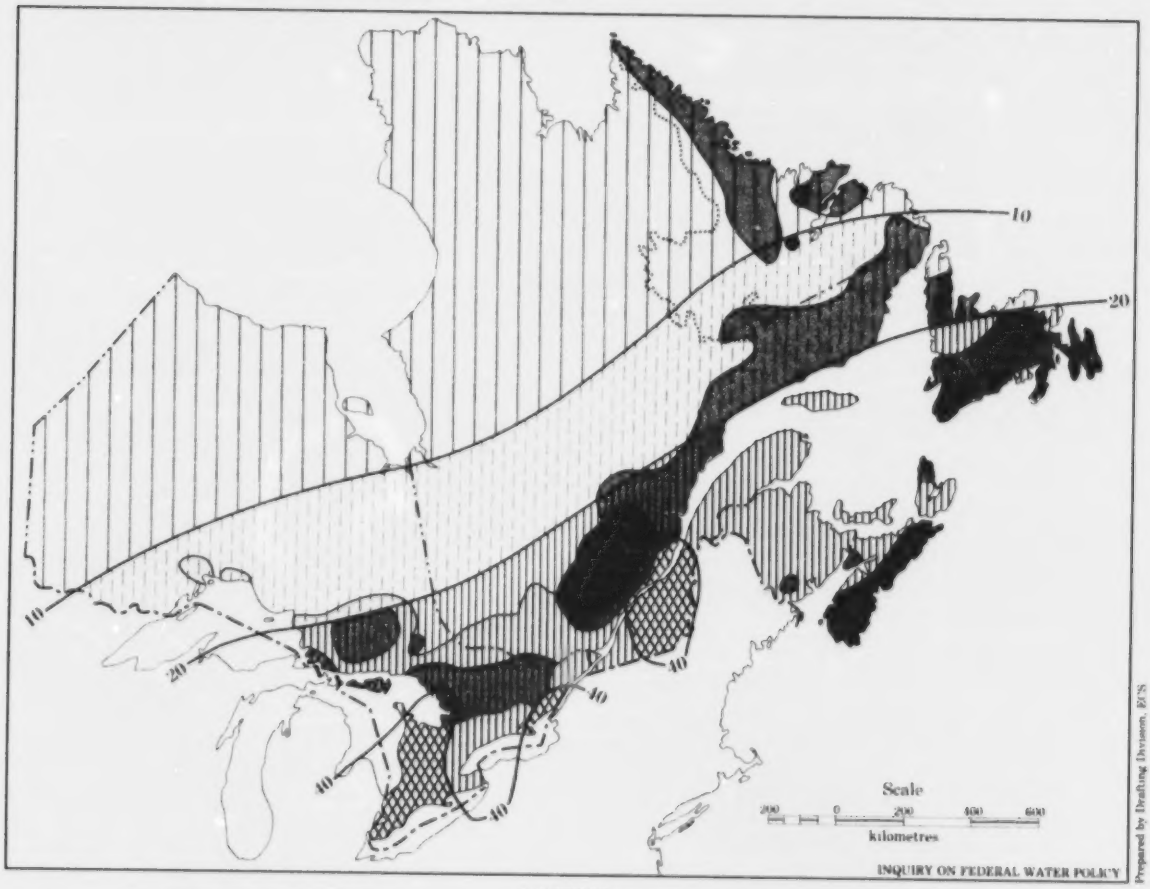
Ontario, Quebec, New Brunswick and Nova Scotia contain significant nuclear power and heavy water production plants; British Columbia, Saskatchewan and Ontario contain major uranium mining developments.

Thermal Pollution

Temperature is one of the most important water quality characteristics for aquatic life. It determines the species of plants and animals the water can sustain, limits the amount of dissolved oxygen and generally influences productivity.

Water temperature naturally varies over the year, and aquatic life is able to tolerate these slow changes provided they remain within a given range. But discharges of waste heat from industrial and thermal or nuclear power facilities can upset the natural thermal regime. An increase in temperature decreases dissolved oxygen and increases the activity of aquatic organisms. Prolonged increases result in warm-water fish species replacing cold-water species. Episodic temperature changes may result in many temperature-sensitive organisms being killed. Thermal pollution may also exacerbate the effects of toxic substances.

Figure 5.4
SULPHATE DEPOSITION AND SENSITIVITY[1] OF WATERS TO ACID PRECIPITATION IN EASTERN CANADA



LEGEND

Wet Sulphate Deposition[2] kg/ha. yr.

- Less than 10
- 10-20
- 20-40
- Greater than 40

Environment Canada has designated 20 kilograms per hectare . year as a target for sulphate deposition as part of an emissions reducing program.

Calcite Saturation Index[3]

- No data available
- 0.0-3.0
- 3.1-5.0
- 5.1-7.0

Values greater than 3.0 reflect areas sensitive to acidification.

Source: Statistics Canada. 1985. *Human Activity and the Environment.* Forthcoming publication No. 11-509, Ottawa.

Note: (1) Sensitivity can be characterized as the potential of a receiving body of water to be stressed by acid deposition and can be quantified using the calcite saturation index.
(2) Wet sulphate deposition is the weight of sulphate in rainfall and snow. Currently this measure is considered to be the best indicator of acidification. Data are from the Canadian Network for Sampling Precipitation (CANSAP) and for 1980.
(3) The calcite saturation index is a composite indicator of surface water buffering capacity and the ability of the water body to neutralize acid deposition.

Sources of Pollution

Some water uses create water quality problems because of the wastewaters they discharge. Municipal sewage, industrial wastes and nonpoint source pollution (e.g. agriculture) are all sources of water pollution.

Municipal Wastewaters

Municipal sewage or wastewater is a major source of water pollution, containing suspended solids, nutrients, heavy metals, and bacteria that can cause disease. It is also a major source of increased biological oxygen demand.

Health and Welfare Canada estimates that the average per capita consumption of water in Canadian municipalities is around 500 litres per day; sewage flows can be expected to equal or slightly exceed this figure.

A national inventory (5) revealed that, in 1984, only 2,164 of Canada's 3,250 communities had sewers. Of these, only 1,442 had some kind of sewage treatment. In fact only 12 million Canadians are served by sewage treatment plants. Table 5.1 shows the extent of wastewater systems in each province and territory.

Quebec serves a small proportion of its population, but the provincial government is currently undertaking a $4.4 billion assistance program to municipalities to establish at least primary treatment for all municipal effluents by 1990. Coastal provinces, especially the Atlantic provinces, treat a smaller percentage of their wastewater than do Ontario and the prairie provinces, mainly because many of them discharge their sewage directly to the ocean.

Given the level of treatment currently in effect in Canada, we can estimate that the sewage discharged daily represents about 1,300 tonnes of BOD and contains 1,200 tonnes of suspended solids. Furthermore, sludges removed during sewage treatment contain metals and toxic substances and most are inadequately treated before disposal.

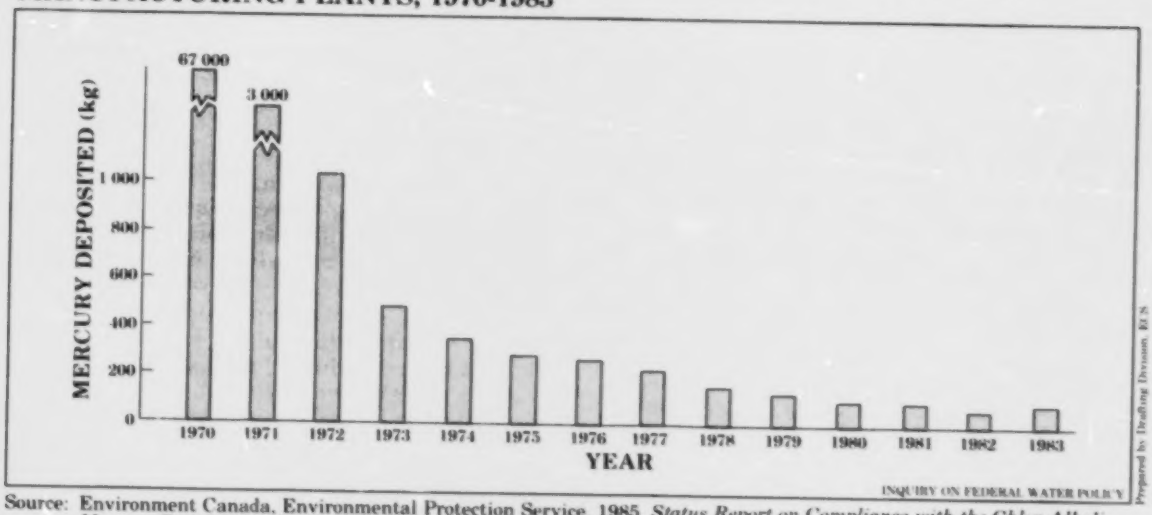
Table 5.1
WASTEWATER SYSTEMS: EXTENT OF SERVICE IN EACH PROVINCE OR TERRITORY

Province or Territory	Total Population Surveyed	Percentage served by sewers	Percentage served by sewage treatment
Newfoundland	497,018	60.0	12.8
Prince Edward Island	57,587	100.0	94.4
Nova Scotia	536,604	83.3	21.4
New Brunswick	409,900	91.8	60.7
Quebec	6,685,434	81.9	6.2
Ontario	7,641,607	86.1	83.5
Manitoba	839,158	94.9	94.7
Saskatchewan	611,072	99.0	99.0
Alberta	1,852,714	99.3	99.3
British Columbia	2,175,754	77.5	77.5
Yukon Territory	21,888	88.0	86.2
Northwest Territories	43,953	91.6	52.5
TOTAL	**21,372,690**	**85.3**	**57.3**

Note: Data are provided by provincial governments on an irregular basis. Although data were compiled in January 1985, they do not represent sewage services at the time but rather the extent of services at the date of last provincial report.

Source: Adapted from Environment Canada, Environmental Protection Service. 1982. *National Inventory of Municipal Waterworks and Wastewater Systems in Canada 1981*. Supply and Services Canada, Ottawa. Data updated to January 1985.

Figure 5.6
MERCURY DEPOSITED IN LIQUID EFFLUENTS FROM CHLOR-ALKALI MANUFACTURING PLANTS, 1970-1983



Source: Environment Canada, Environmental Protection Service. 1985. *Status Report on Compliance with the Chlor-Alkali Mercury Regulations, 1982-1983*. Report EPS 1 HA 1. Ottawa.

Industrial Wastewaters

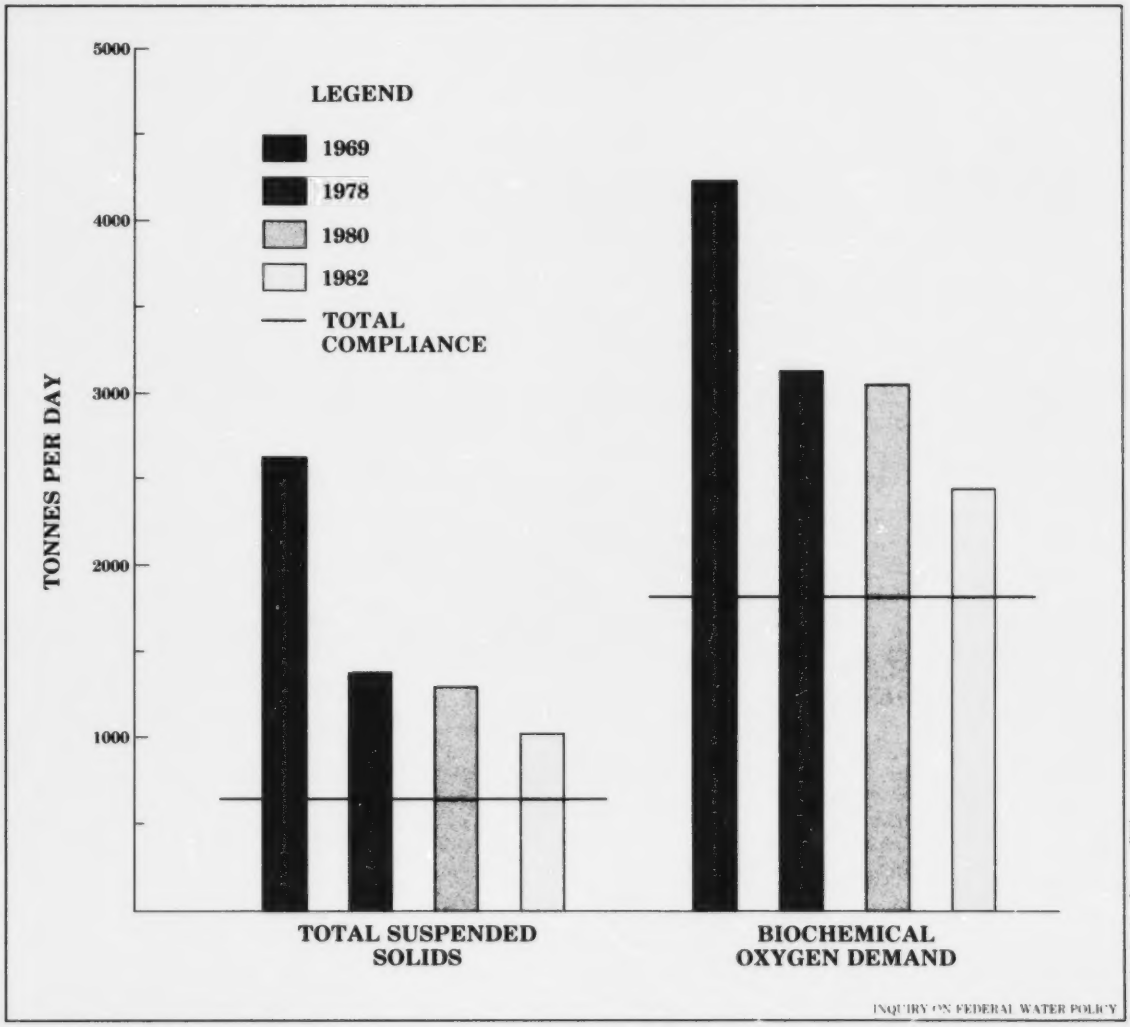
The discharge of industrial waste into waterways is a major concern. In general, industrial wastewaters are more difficult to treat than municipal wastewaters because they contain persistent organic matter and sometimes heavy metals, cyanides, acids and alkali material. In addition, sludges generated by treatment create problems because of their toxicity.

Data on the quantities of industrial waste being discharged to Canadian waters are sparse. And it is difficult to generalize even within a particular industry because plants use different production equipment and the amount of recycling, reclamation and type of waste treatment varies.

Pulp and Paper Effluents. The pulp and paper industry is a major source of pollution in the form of suspended solids and organic substances that increase oxygen consumption. But significant progress has been made since the 1970s largely because tighter regulations have induced mill operators to alter processes to abate pollution. (See Figure 5.5) However, some, mostly old and small mills, have yet to comply with existing regulations. Even with full compliance the pollution from the pulp and paper industry would exceed similar pollution from municipal sources.

Chlor-Alkali Industry. The chlor-alkali industry has been a serious source of mercury pollution originating from the use of mercury cells. Since 1973, the number of plants using this process in Canada has declined from fifteen to five, and mercury discharges have fallen by 99.8 percent since 1970.(See Figure 5.6)

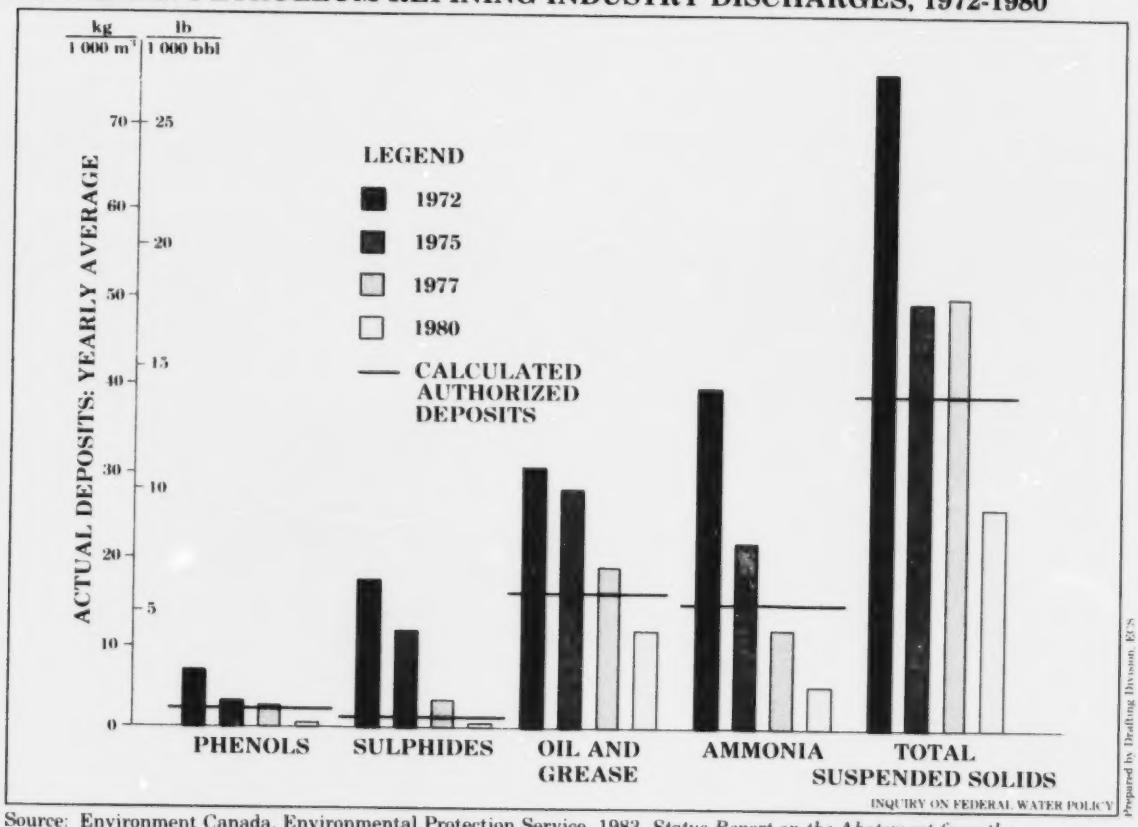
Figure 5.5
PULP AND PAPER INDUSTRY DISCHARGES, 1969-1982



Source: Adapted from Environment Canada, Environmental Protection Service. 1984. *Status Report on Abatement of Water Pollution from the Canadian Pulp and Paper Industry (1982)*. Report No. EPS PF 1, Ottawa.

Note: Total compliance is based on 1982 production level. This total compliance takes into account the actual discharges of mills already in compliance as well as the maximum allowable discharges for mills that are not in compliance.

Figure 5.7
CANADIAN PETROLEUM REFINING INDUSTRY DISCHARGES, 1972-1980



Source: Environment Canada, Environmental Protection Service. 1983. *Status Report on the Abatement from the Canadian Petroleum Refining Industry-1980.* Report EPS 3/WP/83/3. Ottawa.

Note: Reference Crude Rate, 1980: 320×10^{-3} m^3/J

Petroleum Refining Industry. Petroleum refining produces pollutants in the form of oil and grease, suspended solids, phenols, sulphides, ammonia-nitrogen and some toxic substances. But the amounts being discharged have fallen significantly over the years. (See Figure 5.7)

Metal Mining Industry. Metal mining produces many pollutants, the most important being arsenic, copper, lead, nickel, zinc, suspended solids, radium 226 and acids. The amount of pollution is difficult to estimate because effluent discharges vary from mine to mine and volumes are not recorded. Seepage from tailing ponds and abandoned mines are a major concern.

Food Processing Industry. Oil, grease and organic substances that increase oxygen consumption are the primary pollutants from this industry. Although the amount discharged is small compared to other industries, it is sufficient to cause local problems.

Ninety percent of the food processing plants discharge to municipal sewers. Many municipalities have set maximum levels of waste strength to limit the impact of these wastes on sewage treatment processes.

Metal Finishing Industry. The major pollutants from this industry are suspended solids, cadmium, chromium, cyanide, copper, lead, nickel and zinc. A survey made in 1983 showed that only about 60 percent of the effluents generated were being treated adequately. Most of the factories, which are generally small (less than 50 employees), discharge their effluent to municipal sewer systems. Many municipalities have established the amounts and concentrations of pollutants allowed in their sewage system, but inspection and monitoring are often weak.

Chemical Industry. The chemical industry can be divided into inorganic and organic. The inorganic chemical industry produces compounds such as fertilizers, paints, pigments, inks, acids and alkalis and other inorganic chemicals. The organic chemical industry produces petrochemicals, plastics, synthetic resins, dyes, pesticides and specialty chemicals. Potentially toxic, organic chemicals and metals are the primary concerns.

In general, industrial pollution in many areas continues to be a problem because effluents are inadequately treated, treatment systems operate improperly and regulations are inconsistently enforced. Pollution from this sector is difficult to regulate because the pollutants produced by each industry vary so widely.

Nonpoint Source Pollution

Diffuse pollution from land-based activities such as agriculture, forestry, urban drainage, transportation, construction and sanitary landfills has become significant. In the 1970s it became evident that not all pollution problems could be solved by greater pollution control of point sources.

A recent study done on the Qu'Appelle Valley shows that about 30 percent of the phosphorus loading in the Qu'appelle River comes from agricultural and natural runoff. The final report of the International Reference Group on Great Lakes Pollution from Land Use Activities (6) indicates that 30 percent of the total phosphorus load for Lake Erie and 43 percent for Lake Ontario were due to sources other than sewage effluent and industrial wastewater. But reliable methods for detecting contributors to nonpoint pollution have yet to be developed.

Agricultural Runoff. Agriculture is the major source of nonpoint pollution, mostly due to soil erosion. A recent estimate indicates that the prairies lost 160 million tons of soil per annum from wind erosion and a further 117 million tons from water erosion. (7) This is a serious problem because eroded material contains fertilizers and pesticides. causes severe sedimentation in streams and creates heavy oxygen demand.

This is a problem, not only for water quality management, but for the agricultural industry because soil loss threatens the land's productivity and forces farmers to use more fertilizers. Farm animal wastes especially from forced feed lots are also a problem because they lead to concentrated organic loading. Little progress has been made in mitigating these sources of pollution.

Storm Water. The other major source of nonpoint pollution is urban storm water runoff originating from the more than 3,000 municipalities across Canada. In the older municipalities, the sewage systems are designed to carry sewage *and* storm runoff. During periods of heavy rainfall or thaw only a fraction of the total flow can be effectively treated, so some of the combined raw sewage and storm water must be discharged directly into the receiving waters.

New municipalities have separate sewage and storm water systems. The sewage is treated, but the storm water runoff is discharged directly into receiving water. While it is not as polluted as when combined with sewage, it does contain street refuse including lead and oil, domestic animal and bird faeces, de-icing fluids, top soil, fertilizers and pesticides as well a illegal discharges. Its oxygen demand may only be equal to that of treated sewage, but its suspended solids compare to that found in raw sewage, and its heavy metal content may be a significant form of pollution. Because shorelines adjacent to urban discharge are often used for recreational activities, these pollutants and microorganisms could create a health hazard. Methods of controlling pollution from urban runoff are still being developed. (8)

Other nonpoint sources. Other nonpoint sources of pollution include forest harvesting, road construction and municipal or industrial landfills. The leaching of toxic substances from landfills located on the United States side of the Niagara River near Niagara Falls has reached alarming proportions, threatening the water supplies of the dense population around Lake Ontario.

Special Water Environments

Groundwater and estuarial waters present especially difficult problems of water quality management.

Pollution of Groundwater

Groundwater is more protected from the shock of pollutants than surface water. But once contaminated, it is more difficult and expensive to clean up because of its inaccessibility. (9) Groundwater is more difficult to monitor and contamination may remain undetected until a water well or surface body is affected.

Moreover, contaminants mix relatively little with the water, so original concentrations are frequently undiluted. And, chemical or biological transformations occur more slowly than in surface water.

Major sources of groundwater pollution include industrial landfills, mine drainage and tailings ponds, municipal landfills and sewage lagoons, underground storage tanks, enhanced oil recovery operations, manure piles, chemical, oil and brine ponds and spills. Other significant sources and forms of pollution include well-injection operations, pesticides, fertilizers, irrigation practices, septic tanks and abandoned wells. Salt water intrusion, de-icing salts and animal feed lots also contaminate groundwater. (9)(10)

Improper disposal of municipal and industrial wastes including hazardous wastes accounts for the most serious groundwater pollution. Continued use of pesticides and fertilizers in the agricultural industry could also be a problem in regions heavily dependent on groundwater such as Prince Edward Island.

Pollution of Estuarine and Coastal Waters

Estuaries, where rivers meet the sea, comprise the most biologically productive areas on the Canadian coastlines. They are also centres of industry and population. Thus, estuarine use conflicts are frequent and increasing.

Estuaries are often the scene of transportation and log handling activities and the receiving bodies for wastewaters from industry and municipalities. In some areas, municipal wastes and agricultural runoff are causing serious eutrophication. (11) In addition, their delicate balance of freshwater, saltwater, vegetation and sediment is affected by dykes, dams and diversions, which alter river flow regimes, affect the saltwater wedge penetration and reduce sediment input. These all create considerable pressures on fish and wildlife.

Other coastal waters are suffering serious degradation as well. Many coastal municipalities and industries continue to discharge their untreated or partially treated wastewaters to the sea. While coastal waters have a considerable capacity to assimilate and disperse wastes, this capacity is being strained by general pollution and by toxic and persistent contaminants.

Summary

This overview of pressures on water quality shows that some mitigation measures for conventional sources of pollutants, such as municipal and industrial wastewaters, have been remarkably effective. The marked reduction in nutrients being discharged into the Great Lakes and the sharp reduction in mercury discharges from the chlor-alkali manufacturing industry are examples.

But the less conventional types of pollution have become more prevalent and the traditional approaches to pollution control may be inadequate to cope with them.

Solutions to these new water quality problems cannot be found in improved technology alone; most of them call for social and political choices. They also require that some of the tools used during the 1960s (laws, regulations, policies, programs) be modified or even replaced by new and more adequate tools. We return to these needs in subsequent chapters.

Part III

The Legal Framework

PART III
THE LEGAL FRAMEWORK

The federal government's water policy consists, not only of objectives, but also of the means to meet those objectives: legislation, institutions, administrative arrangements and all the instruments and procedures that affect how water is used and developed. This part of the report deals with the legislation, which includes the constitution, statutory law and international agreements. Together they define the limits of the federal role.

Chapter 6 reviews the constitutional division of powers between the federal and provincial governments. Chapter 7 considers the legislative framework which the federal government has adopted to implement its domestic constitutional responsibilities. Chapter 8 focuses on the arrangements Canada has made with the United States and other countries regarding water. Subsequent chapters deal with federal administrative structures and procedures for executing its responsibilities.

Water gives rise to some of the most convoluted and complex issues in constitutional law. Our brief sketch in the following pages leaves out the detail and most of the qualifications that experts in water law would want included. However, our synopsis is based on extensive research, some of which has been published separately in research papers.

Chapter Six

The Constitutional Base

We do not believe that it is necessary to amend the Constitution. The role of the Federal Government should be to provide leadership through cooperation with the other levels of government and the private sector to develop general policies and provide incentives . . .

ASSOCIATION OF CONSULTING ENGINEERS

We have found that the division of jurisdictional authority over water in Canada sometimes gives rise to tensions between the federal and provincial governments. Our approach has been influenced by these tensions, as we searched for ways to alleviate sources of conflict. To some extent, however, conflicts are inevitable in a federal state and some stress may even be desirable.

Under any interpretation of Canada's constitution, the provinces have wide jurisdiction over water. We believe that federal policy should respect this broad provincial authority, intervening only when an issue of federal or national interest is at stake. Our conclusions will, therefore, disappoint those who argue that the pervasiveness, acuteness or cost of solving water management problems in Canada would justify federal intervention. Nor will we satisfy those at the other extreme, who argue that federal attention to its responsibilities has been sufficient or even excessive. We recognize the need for the federal government to diligently and vigorously dispatch its responsibilities, just as the provinces must attend to theirs.

Having said this, we want to point out that the administration of water matters by federal and provincial governments need not be divided along the same lines as their formal responsibilities. The overlap and interdependence of responsibilities suggest to us that we should take advantage of Canadian experience in delegating administrative responsibilities between governments to eliminate conflict, enhance consistency and improve efficiency.

It must be added that the general public is not interested in all these niceties. Participants in our public hearings displayed a widespread impatience with the formal division of authority in the face of urgent problems demanding attention. This is not to say that the constitutional assignment of responsibilities is unimportant, but rather that the public wants those formalities reconciled or overcome so that they will not impede proper water management.

In view of these circumstances and our terms of reference, we have adopted an approach that starts with the constitution. It would be relatively easy, but undoubtedly naive, to simply recommend constitutional amendments that would resolve all jurisdictional problems in water management. Instead, we take the constitution as given, with all its imperfections, and turn to it as the ultimate authority for defining the federal mandate.

The constitution does not mention water. (1) It does deal with some water uses, such as navigation, fisheries and, more recently, electrical energy generation. But most questions of jurisdiction must be inferred from the constitution's treatment of other issues, like property rights, criminal law, foreign relations and so on. Moreover, few jurisdictional disputes over water have been litigated in Canada, no doubt partly because most of the population has relatively abundant water supplies. The combination of indirect reference to water in the constitution and limited guidance from the courts makes it impossible to define precisely the respective roles of the federal and provincial governments in water management.

When the four colonies confederated in 1867 to become the first provinces of Canada, they agreed on a constitution that gave the provinces authority over most natural resources within their borders. These terms also applied to the provinces that joined Canada later, though the transfer of responsibility for resources to the prairie provinces was postponed until 1930. Inland waters were simply among the natural resources over which the provinces assumed authority and control.

Provincial Powers

The provinces' law-making power over water derives from specific clauses in the constitution that assign to them jurisdiction over "property and civil rights" and "the management and sale of public lands". Water is traditionally regarded as a form of property, and the term "public lands" is taken to include water: so these provisions convey a general provincial power over water. Other parts of the constitution give the provinces control over local works and undertakings and "all matters of a merely local or private nature" within their borders. And a 1982 amendment to the *Constitution Act* specifies that provincial governments have jurisdiction over electricity generating works. The extent to which such projects are subject to constraints under federal powers has yet to be clarified. (2)

All these constitutional provisions give the provinces considerable authority over water within their boundaries. However, provincial jurisdiction is limited by specific powers assigned to the federal government.

Federal Powers

The constitution provides for exclusive federal jurisdiction over some matters that bear on water management. Among these are the federal authority over fisheries, navigation, relations with foreign governments, federal lands, Indians, works for "the general advantage of Canada" and "peace, order and good government". The authority to legislate on these matters limits the provinces' authority over water.

Some of these federal responsibilities have a direct and continuing impact on water management. The constitution gives the federal government exclusive authority over navigation, which empowers it to pass laws, such as the *Navigable Waters Protection Act*, to regulate activities in navigable water. The courts have adopted a generous definition of navigability, so any significant project on even a small river requires federal approval. But regulatory intervention under this authority must be justifiable on the specific grounds that it protects navigation.

The federal government is assigned responsibility for all fisheries in Canada, and so can pass laws, such as the *Fisheries Act*, to protect and manage fish. More importantly, this law-making power includes protecting and managing fish habitat, which involves the federal government in regulating activities that alter either the flow or quality of water in a way that would be harmful to fish.

However, provinces also have some jurisdiction over fisheries because common law defines fisheries as property, a provincial responsibility. Responding to this conflict, courts have ruled that federal powers are limited to the regulation and protection of fish, and prohibit federal regulation of activities (such as fishing) that would prejudice the provinces' rights as owners. Considerable legal controversy surrounds this complicated matter.

Continuing federal involvement in water management also results from its direct responsibility for federal lands and for administering a trust relationship with native peoples. Thus, the federal government has full control over water in Yukon and the Northwest Territories, in national parks and, generally, on Indian reserves. Jurisdictional complexity may acquire a new dimension as native people's treaty and aboriginal rights are defined and their authority to establish self-government is resolved.

Aside from federal responsibilities for international matters (discussed in Chapter 8), the remaining federal powers are mainly potential. Authority over criminal law and national defence might be invoked in certain cases. The federal government could also declare a "work" (a dam, for example) to be for "the general advantage of Canada" and thereby take over full control, although this has not been done for almost a quarter of a century.

The controversial federal power to legislate for the "peace, order and good government" is referred to as a residual power because it can accommodate any matters not assigned to either order of government elsewhere in the constitution. But some provincial powers (such as those relating to property and civil rights) can be so broadly defined that it is difficult to decide whether something falls under the provincial power or this federal residual power.

The federal responsibility for peace, order and good government could be important for managing water in Canada, but at present its scope is unclear. For many years, this power was held to justify federal intervention only if it arose out of a "national emergency", such as war or famine. How-

ever, forty years ago the courts began to apply a less restrictive test, justifying federal legislation if it dealt with a matter of "national concern" beyond local or provincial interest. Then, in 1976, the Supreme Court reverted to the "national emergency" criterion in a ruling about a federal anti-inflation program. The difference between these two interpretations is significant in the present discussion: many water problems, especially those that extend across two provinces, might well justify federal intervention as matters of national concern but not as matters of national emergency.

At present, experts generally hold that federal legislation applied to a whole area of jurisdiction, such as pollution control, could probably be justified only in an emergency. However, federal intervention in specific and limited cases, such as the pollution of an interprovincial river, might be valid if the issue can be described as one of national concern. The residual power thus gives the federal government a possible (but controversial) basis for regulating water use beyond its specific constitutional powers.

Joint Powers

Although some responsibilities overlap, as does federal authority over fisheries and provincial authority over property, the constitution is assumed to have allocated all responsibilities to either the federal or provincial governments with one important exception: The constitution permits both federal and provincial governments to legislate with respect to agriculture, but it provides that federal legislation will prevail in the case of a conflict.

This joint power is important for the administration of water resources, especially in the prairies where irrigation dominates water use. It enables the federal government to pass laws, such as the 1935 *Prairie Farm Rehabilitation Act*, to deal with drought and erosion problems. However, unilateral federal legislation of this kind threatens to encroach on provincial authority over property, so most water projects (including those constructed by the Prairie Farm Rehabilitation Administration) are carried out by agreement with the provinces.

Other Federal Activities

In some matters that appear to be largely provincial responsibilities, the federal government may still play a significant role. For example, though the federal government has no specific jurisdiction over health, it can legislate to deal with health problems under its powers relating to criminal law, interprovincial and international trade and (in narrow circumstances) peace, order and good government. Some doubt remains, however, whether these powers would support federal legislation to protect municipal drinking waters.

In addition, the federal government is active in a range of water-related activities that have national significance and enjoy provincial support, such as data collection and research. The federal government also provides financial assistance to provincial programs in the name of regional economic development.

Authority Over Interjurisdictional Waters

One additional matter of constitutional uncertainty must be explained because of its importance for water management and for appreciating our recommendations in the following chapter. That is the authority of the federal government to intervene where waters flow from one province or territory into another, or along their common boundaries.

This is an important issue because many lakes and rivers abut or cross boundaries within Canada, and because activities in one jurisdiction can impair the flow or quality of water available to other jurisdictions. This can pit one jurisdiction against another, and create disputes among private interests in different jurisdictions. It is also a controversial matter because any federal controls imply constraints on the provinces' authority to manage water.

Although we speak here generally of surface drainage, the same problem would of course exist if an underground aquifer shared by two or more jurisdictions were depleted or contaminated. Transboundary groundwater issues are likely to emerge in Canada in the near future.

For many years it was widely assumed that each province enjoyed virtual sovereignty over the waters within its boundaries. This meant that, as long as federal jurisdiction over navigation and fisheries was respected, an upstream province could pollute or interrupt the flow of waters regardless of how that affected a downstream province.

That prevailing assumption was challenged a decade ago when the famous Interprovincial Co-operatives case (3) was referred to the Supreme Court of Canada. Industrial operations in Ontario and Saskatchewan had polluted with mercury, rivers that flowed into Manitoba. Because of the pollution, Manitoba was forced to close certain fisheries. Having paid financial compensation to the fishermen who lost their livelihood, it attempted to sue the polluters in the upstream provinces. Much of the case centred on the question of whether the wrongful act was committed in the jurisdiction where it took place (i.e. Ontario and Saskatchewan, where it was properly licensed) or in the jurisdiction that had suffered damage (Manitoba).

The case was complicated, and the judges were divided in their conclusions, but certain results are important in the present context. The majority of the judges concluded that, because the polluting activities were licensed in Saskatchewan and Ontario, Manitoba could not object. However, the Chief Justice and two other judges held that if Manitoba could not interfere with civil rights in Saskatchewan and Ontario, neither could those provinces interfere with the rights of Manitobans to clean water. Thus, an upstream province could not authorize activities detrimental to those in downstream jurisdictions. This minority view was not contradicted by the rest of the court. When it is considered along with the increasingly favoured legal view that a wrongful act is committed in the jurisdiction where its effects are felt, one must conclude that a development on an interjurisdictional river may well trigger court action if it has harmful effects in the downstream province or territory.

The Interprovincial Co-operatives case has left a void in authority over interprovincial rivers. All judges agreed that the pollution of interprovincial rivers is to some extent a federal responsibility. But comprehensive federal legislation to deal with this matter would have to be justified under the federal responsibility for peace, order and good government. In the absence of valid federal legislation, it is difficult to predict how the courts would deal with such problems; for example, they might invoke the United States doctrine that interjurisdictional waters must be "equitably" shared, or the common law of riparian rights that entitles those downstream to water that is not substantially impaired in either volume or quality by upstream users. But, undoubtedly, the ideal solution to such problems would be for the provinces or territories along the watercourse to agree on the uses each may make of it.

In the following chapter, we return to this important problem in the context of the legislative underpinnings of federal water policy.

Chapter Seven

The Framework of Federal Water Law

Legislation concerning water resources management has not been developed in a planned manner but, rather, on an ad hoc basis by various levels of government in response to emerging situations. The result is a fragmented legislative base . . .

ENVIRONMENT CANADA, ATLANTIC REGION

Under the various powers the constitution assigns to it, the federal government has enacted a good deal of legislation that bears in one way or another on water use. This chapter sketches the central core of that statutory framework and assesses it only in just enough detail to explain our recommendations. Further analyses of federal water legislation can be found in our research papers. (1)

We discuss in this chapter several different kinds of federal statutes. One kind deals mainly with specific water uses, such as fisheries, navigation and agriculture. Another focuses on water quality protection, either generally or from particular sources of pollution. A third supports our international treaty responsibilities. And a fourth takes a comprehensive approach to water management. These are not mutually exclusive categories, however, because some statutes like the *Fisheries Act* fall into more than one.

We largely omit a fifth category, a variety of federal legislation that bears only incidentally on water use. The *National Parks Act*, for example, is concerned mainly with establishing and administering parks and only touches on the administration of water uses within them. We do not consider these because they do not influence water management in Canada in a general and important way.

Finally, we address certain issues for which federal legislation has not provided, or cannot provide, solutions.

Fisheries Legislation

The federal government's main instrument for managing fish is the *Fisheries Act*, (2) an old statute that actually predates Confederation and has been patched with innumerable amendments over the decades. The Act deals primarily with regulating fishing and managing fish stocks. But it also contains provisions for protecting fish habitat. These support the most important federal water quality controls in Canada.

The *Fisheries Act* protects fish habitat in three ways:

First, it empowers the Minister of Fisheries to require anyone who builds an obstruction in a waterway to build either a fishway around it or a hatchery to compensate for damaged stocks.

Second, it prohibits anyone from disturbing fish habitat except with the Minister's approval. Fish habitat is defined broadly, and since nearly all economic operations in a watershed alter habitat in some way, this provision is very comprehensive.

Third, it makes it an offense to deposit any "deleterious substance of any type in water frequented by fish" or anywhere else if it might find its way into such water. Since almost any substance in sufficient concentrations can be deleterious to fish, and since most land drains into watercourses frequented by fish, this prohibition is also very comprehensive.

Because the federal government lacks other means, such as licensing, to regulate users of water, land and other resources, it needs strong, punitive legislation to support its constitutional responsibilities for managing fish and their habitats. Those parts of the *Fisheries Act* that prohibit disturbance and pollution of fish habitats have these essential characteristics, so we do not propose they be changed.

However, as it is presently administered, the Act ignores all other legitimate uses and users of water except to prohibit them from disturbing fish. Provincial governments, industrial interests and public administrators have all reproached it as being an obstacle to modern, integrated resource development. We share this concern, being committed as we are, to the principle of comprehensive resource planning and management.

We are also concerned about the strain that the present arrangements put on intergovernmental relations in circumstances where cooperation and coordination are crucial. The Act's presumption that fisheries must always occupy a pre-eminent position, and that other uses such as waste disposal, forestry and power generation must always yield, forces fisheries officials into confrontations with other provincial, territorial and federal agencies.

Clearly, some changes are urgently needed in how this legislation is implemented. In the following sections, we suggest what changes need to be made.

Protection from habitat disturbance

Anyone who disturbs fish habitat is liable to prosecution. This means that many industrial operations, especially forestry, mining and construction activities, are constantly in technical violation regardless of how much (or little) disturbance they cause or whether it is in the public interest. Not surprisingly, enforcement is controversial and erratic. The only flexibility is in a provision that allows the Minister to exempt an operation, but this has rarely been exercised. To enable greater flexibility, the following changes need to be made.

First, fisheries officials should be empowered to engage in integrated resource management planning, in which fish habitat protection is considered within a more comprehensive framework of resource uses and values.

Second, opportunities should be explored for delegating authority to protect fish habitat to other levels of government, at least in those jurisdictions where Fisheries and Oceans Canada does not have a strong presence, such as in the prairie provinces.

Third, a project proponent should have the right to call for approval of a project before starting it if he is willing to provide all required plans and related information. Similarly, the Minister should have the authority to require an approval for any project that appears threatening to fish habitat. Formal approvals should not be compulsory for all activities in a watershed because this would be unmanageable. This arrangement is analogous to the binding advance rulings one can obtain from Revenue Canada about the tax consequences of a venture in which investment is contemplated.

Finally, the interested public should have adequate opportunities to learn about proposals for major projects and to comment on them. In some cases, provincial or other federal agencies will provide suitable public hearings or other forums. However, where no other provision is made for publicly reviewing the fish habitat implications of a proposed development, the Minister of Fisheries and Oceans should have the power to authorize public hearings. Thus, we recommend:

7.1 The *Fisheries Act* (Section 31) and Regulations should be amended to enable the habitat requirements of fish to be considered within the framework of integrated resource management of water systems. These changes should include the following:

- **i) provisions to enable officials of Fisheries and Oceans Canada to formally engage in integrated resource planning and management with provincial, territorial and other federal agencies.**
- **ii) powers to delegate administrative responsibility for these matters to provincial and territorial agencies in appropriate circumstances.**
- **iii) arrangements to enable project proponents as well as the Minister of Fisheries and Oceans to call for approval of planned projects, and procedures for applying for approvals and reviewing plans.**
- **iv) authority for Fisheries and Oceans Canada to approve plans and formally authorize activities carried out according to the approved plans.**
- **v) where other avenues are not provided, provisions for the Minister of Fisheries and Oceans to hold public hearings at his discretion on development proposals that will affect fish habitat.**

Some of these arrangements are already in place in some provinces, albeit inconsistently and with questionable legal foundation. A "referral system" in British Columbia enables federal fisheries officials to examine and comment on resource development plans referred to them by provincial agencies. Fisheries officials in Newfoundland have adopted the practice of signing

approved plans, though the legal significance of this is unclear.

Prodded by recommendations of the recent Royal Commission on Pacific Fisheries Policy, Fisheries and Oceans Canada has been preparing a new policy on fish habitat management. As this report was being written, the department released a position paper on this subject (3), which incorporates the basic principles of integrated resource management advocated here. We urge that our recommended changes in regulations and procedures be made promptly to enable these principles to be implemented.

Protection from pollution of fish habitat

Because the prohibition against depositing deleterious substances is so rigid, few waste discharges can conform to the letter of this law. Obviously, it does not lend itself to consistent enforcement.

To complicate matters, the deleterious substance section of the *Fisheries Act* is administered by the Environmental Protection Service of Environment Canada unlike the rest of the *Fisheries Act*, which is administered by Fisheries and Oceans Canada.

As an expedient way of administering this part of the Act, the Environmental Protection Service exempts *all* effluent discharges that are within concentrations specified in regulations. Regulations have been adopted for six industrial groups, the four main ones being pulp and paper, petroleum refining, chlor-alkali, and metal mining. For these, uniform effluent standards are applied as minimum requirements throughout Canada.

Uniform standards for effluent discharged into waterways that vary widely in their size and other conditions cannot consistently protect fish habitat, however. Later, in chapter 10, we propose that these fixed industry standards be gradually superceded by site specific approvals, based on the environmental pressures and circumstances of each case. These site specific approvals will be consistent with those recommended above, and should be integrated with them where an undertaking requires both.

We also propose later that water quality guidelines be designed for the various water uses. This would ensure that, when approvals are issued under the *Fisheries Act*, the dilution and assimilative capacity of each watercourse, the fisheries values and the competing demands on the resource are all taken into account.

Control of Hazardous Contaminants

The federal parliament passed the *Environmental Contaminants Act* (4) in 1975 to prevent dangerous contaminants from entering the environment. It is potentially a major instrument for federal control of toxic and dangerous substances that may pollute water.

This Act empowers the federal government to undertake several activities. One is to obtain information from manufacturers, processors and importers about substances used in their products that the Minister of the Environment considers potentially dangerous. Another is to conduct research on dangerous contaminants, either alone or in cooperation with provincial governments. We have no objection to these provisions.

The Act also aims at giving the federal government power to prevent certain serious kinds of water pollution. To this end, it authorizes the Minister of the Environment and the Minister of National Health and Welfare to jointly compile a list of substances that pose a significant danger to human health or the environment. Once a substance is listed, no one may release it into the environment except under strict regulations. Only five substances have been listed so far: polychlorobiphenyls (PCBs), polybrominated biphenyls (PBBs), polychlorinated terphenyls (PCTs), mirex and chlorofluorocarbons.

The problem with this provision is that it puts the onus on the government to identify environmental contaminants, and calls for product safety tests and information only *after* the Ministers have concluded that the substance constitutes a danger. Thus, a toxic substance might be released for some considerable time before the Ministers were alerted to the problem and had the substances listed. This contrasts with some other legislation, such as the *Pest Control Products Act* (5), that requires manufacturers of new pesticides to register their products

before they may be sold in Canada.

Our public hearings made it clear that this is precisely the kind of risk that causes widespread anxiety among Canadians, especially those living in industrial regions. Environment Canada has been studying this problem. Given the pace at which new chemicals and compounds are introduced and the difficulty of maintaining close governmental surveillance, we recommend:

7.2 The *Environmental Contaminants Act* should be amended substantially to place the onus on producers, importers and users of toxic substances that fall within certain categories (to be listed in regulations) to seek approval and registration of those substances before they are marketed or used.

Regulations pursuant to the Act would list broad categories of substances that must be approved and, as under the pesticides controls, new products or processes involving them would require approval.

This proposal will likely be criticized on grounds that it would delay the introduction of new products. This is a legitimate concern, and suggests a need for care in listing types of substances to be regulated. It also implies a need for improved testing arrangements. Nonetheless, some delay and inconvenience will inevitably result. But the submissions we received convinced us that Canadians generally are willing to incur this cost to avoid the environmental risks associated with the present policy. In our view, this is one of the areas in which the federal government should play a much more vigorous part in environmental protection.

If the *Environmental Contaminants Act* is amended as suggested, another less significant change could also be made. About 1970, controls on phosphates in laundry detergents were included in Part 3 of the *Canada Water Act* since no other piece of federal legislation existed under which they could be controlled. Now that the *Environmental Contaminants Act* exists, it would be desirable to bring this provision under its umbrella. We therefore recommend:

7.3 The controls on cleaning agents and water conditioners that contain harmful nutrients, now in Part 3 of the *Canada Water Act*, should be integrated into the *Environmental Contaminants Act*.

With this amendment to the *Environmental Contaminants Act*, Part 3 of the *Canada Water Act* should be repealed.

Other Pollution Control Legislation

Certain other federal statutes are aimed at controlling pollution of one kind or another, two of which deserve mention here.

The *Canada Shipping Act* (6) deals with the special problem of controlling pollution from ships. Most of this Act refers to pollution in maritime waters, but certain provisions impose penalties for dumping pollutants from ships in inland waters and for failing to report a spill. We consider this legislation to be adequate for its special purpose.

The *Atomic Energy Control Act* (7) deals with radioactive substances such as uranium and plutonium. The Act governs development and use of atomic energy generally, and creates the Atomic Energy Control Board for these purposes. The board is responsible for controlling pollution from uranium mining, heavy water production and nuclear plants. The continuing difficulty with regulations appears to be in defining appropriate water quality objectives for radionuclide concentrations in wastewater effluent. Concentrations in nature are sometimes higher than those specified in drinking water requirements on which the objectives are based.

Navigation Legislation

The *Navigable Waters Protection Act* (8) among other things, forbids anyone from constructing anything in a navigable water, broadly defined, without the permission of the Minister of Transport. It also prohibits dumping wastes where they might interfere with navigation.

This Act gives the government strong powers to protect the navigability of waterways and thereby to influence water projects, but its powers have not always been fully exercised. Notably, the Bennett dam on the Peace River in British Columbia was built in the 1960s without the Minister's approval.

Our only criticism of this legislation is its lack of clarity about what constitutes a "navigable water". Transport Canada has relied on the common law definition, which rests on traditional and historical use and may include streams only large enough to carry a canoe or float a log. Thus, the full brunt of this legislation can be brought to

bear against projects on mere creeks, which do not and cannot support navigation in the normal sense. This strains the credibility of regulations concerned explicitly with navigation and invokes administrative burdens and costs of doubtful justification.

In testimony at our public hearings, Transport Canada informed us that this problem has been the subject of lengthy discussion internally, but progress in resolving it has apparently been slow. We believe the problem warrants more urgent attention. Accordingly, we recommend:

7.4 The Minister of Transport and the Minister of Justice should accelerate the review of the *Navigable Waters Protection Act*. Among other things, this review should aim at clarifying the definition of "navigable water" for the purposes of this legislation.

In the meantime, Transport Canada should be urged to expedite its procedures for approving activities that have no significant impact on navigation.

Agriculture Legislation

Of the federal legislation relating to agriculture, the *Prairie Farm Rehabilitation Act* (9) has the most important bearing on water management. This Act was originally passed in 1935 in response to the disastrous drought that coincided with the Great Depression. It empowers the federal government to develop water supplies and promote land-use practices to rehabilitate the drought and soil-drifting areas in the three prairie provinces.

Certain deficiencies in the *Prairie Farm Rehabilitation Act* have come to our attention. First, while the Act was initially given a life of five years to respond to the 1930s' crisis, it was renewed and has remained in effect even though the emergency that spawned it has long passed. Second, the regulations needed to properly implement the Act were never passed. Third, it is unusual federal legislation insofar as it applies only to a portion of Canada's agriculture -not even to all areas that experience drought. And fourth, federal involvement in agricultural water projects is now based, formally or informally, on federal-provincial agreements, which we believe is preferable to unilateral federal legislation.

In view of these concerns, we recommend:

7.5 The provisions in the *Prairie Farm Rehabilitation Act* that relate to water development should be reviewed in light of modern conditions and needs. This review should consider, among other things:

- **i) The appropriateness of this legislation as a means of providing for agricultural water development projects.**
- **ii) The desirability of the limited geographic application of the Act.**
- **iii) The need for regulations to provide guidance about the interpretation and application of the legislation.**
- **iv) The appropriate scope of activities provided for under the Act.**

In a later chapter we review the purpose and programs of the Prairie Farm Rehabilitation Administration, and offer suggestions that should be considered in this legislative review.

Legislation Supporting International Responsibilities

Many of our major rivers and lakes cross or define our border with the United States. Since the constitution makes all dealings with other states a federal responsibility, the federal government becomes involved in managing these waterways.

The federal government has enacted several statutes to enable it to attend to these international responsibilities. Chapter 8 deals specifically with international arrangements, so we only note the relevant legislation here.

The *International Boundary Waters Treaty Act* (10) implements Canada's 1909 Boundary Waters Treaty with the United States; and the *Migratory Birds Convention Act* (11) implements the 1916 convention with the United States to protect migratory birds, and gives the federal government powers to control pollution of waterfowl habitat.

The federal government passed both of these Acts under a constitutional provision that empowers it to perform obligations arising from treaties between "the British Empire" and foreign countries. Both of the relevant treaties were entered into by Great Britain, on behalf of Canada, before Can-

ada achieved independence. Any treaties Canada entered into since it became an independent state (such as the 1950 Niagara River Water Diversion Treaty) are *not* covered by this provision. So, if they affect areas of provincial responsibility, they require provincial legislation to implement them. It is no longer possible, therefore, to simply pass federal legislation to implement international treaties.

Finally, the *International River Improvements Act* (12) prohibits anyone from damming or changing the flow of a river flowing out of Canada except with federal approval. This Act was passed in 1955 to prevent British Columbia from building a major dam on the Columbia River against the wishes of the federal government; but it applies to all rivers flowing into the United States. It limits, in these cases, the provincial governments' authority to license water projects within their provincial boundaries. This is considered justifiable under the constitution's provisions for peace, order and good government on grounds that interrupting the flow of a transboundary river could lead to serious international incidents.

Comprehensive Water Legislation

The legislation referred to above illustrates the federal government's traditional concern with particular water issues associated with federal responsibilities under the constitution.

In 1970, the federal government made its first attempt to deal more generally with freshwater management by enacting the *Canada Water Act* (13) and the *Northern Inland Waters Act* (14). The latter is restricted to the Yukon and Northwest Territories, where unique institutions — territorial water boards composed mainly of territorial residents — license water use and water disposal activities. Because federal jurisdiction in the territories differs fundamentally from that in the rest of the country, we defer discussing the *Northern Inland Waters Act* to Part V, which deals with water policy in the north.

The *Canada Water Act* replaced the *Canada Water Conservation Assistance Act* of 1953, which allowed the federal government to share the cost of building water storage facilities. That Act was used primarily to support flood control projects; the *Canada Water Act* provides a much broader scope for federal activity.

The *Canada Water Act* consists of four parts, the first two of which are particularly important here. Part 1 deals mainly with water management; Part 2 deals with water quality management. Because the federal government has limited constitutional authority in water management, the Act's recurrent theme is federal-provincial cooperation. Both parts authorize the federal government to join the provinces in a wide range of activities including planning and implementing projects.

Part 1 of the Act authorizes the federal government to enter into agreements with provinces for conducting research and water inventories, formulating comprehensive management plans, and designing and executing projects.

The federal government may undertake such programs unilaterally with respect to waters over which it has full jurisdiction. Such is not the case with interjurisdictional waters; the federal government may develop programs on interjurisdictional waters only if it has attempted and failed to reach agreement with affected provinces, the water is an international boundary or a transboundary water, and the project is of significant national interest.

Over the fifteen years since the *Canada Water Act* was passed, federal-provincial agreements have enabled a wide variety of water resource surveys, studies and programs, which we review later in this report.

Part 2 of the Act has never been exercised, nor have the federal and provincial governments ever seriously considered doing so. Its provisions authorize agreements for designating water quality management areas and for establishing agencies to deal with pollution within these areas. These agencies would formulate water quality management plans which, when approved by the Ministers of the governments involved, could enable significant cooperative activity.

If a plan were approved, the agency would be empowered to design, construct and operate waste treatment facilities, collect fees for effluent discharges and waste treatment, monitor water quality and perform other water management activities.

Part 2 of the Act has suffered heavy criticism on several grounds. First, it imposes severe constraints on the federal government's ability to respond to serious pollution problems: apart from federal waters, it may act only when water quality has dete-

riorated to the point of an "urgent national concern". Since the federal government can become involved only if the province concurs, this restriction seems unnecessary. Moreover, the Act should encourage federal and provincial governments to cooperate in managing water quality before it deteriorates to the critical level of "urgent national concern".

Second, it threatens provincial jurisdiction. If a province entered into a water quality management agreement, and then the agreement was terminated because the federal and provincial governments failed to agree on water quality standards, the federal government could unilaterally establish a water quality management agency. Thus, a province might face a greater threat of unilateral federal intervention if it enters into an agreement than if it does not.

In any event, no water quality management agreements have been entered into, and the federal government has not used its powers of unilateral action. Nor does it appear likely that this part of the Act will be used in future.

Finally, we question the rationale for this part of the Act. Part 1 of the Act is undoubtedly sufficiently broad to enable agreements to deal with matters of water quality.

For all these reasons, we have concluded that Part 2 of the *Canada Water Act* is dispensable. But before we make a specific recommendation, we must turn to the related problem of the federal role in interjurisdictional waters within Canada.

Responsibility for Interjurisdictional Waters

In the preceding chapter we drew attention to the uncertain legal status of waters flowing along and across boundaries between provinces and territories. This issue must be clarified since many of Canada's major water bodies and hundreds of streams straddle or cross jurisdictional boundaries.

As pressures on water resources grow, it becomes increasingly urgent to ensure that, when Canadians in one jurisdiction use or contaminate water, they take account of impacts on other Canadians in other jurisdictions. This is in the interests of equity and national harmony and is also required by our principle of integrated water management. The needed assurance that transboundary impacts will be considered is now lacking. The same situation applies to underground aquifers, though no interprovincial conflicts have yet arisen.

The prevailing uncertainty surrounding interjurisdictional waters is the most fundamental deficiency in Canada's water policy. Indeed, as we show in the next chapter, the arrangements governing interjurisdictional waters within Canada are now more ambiguous than those governing international waters. This issue must be resolved to avoid increasing conflicts and undesirable patterns of water use and to meet the challenges of modern resource management.

Current risks

Continuing the present uncertain status of interjurisdictional watercourses carries serious risks. First, it is likely to impede negotiations among jurisdictions for sharing common waters because no clear legal guidance or ultimate sanction exists. We found that few apportionment agreements have been reached and that no agreements have been reached for controlling pollution in interjurisdictional waters.

Moreover, even where agreements exist, enforceability is doubtful. All provinces except Quebec have passed legislation providing that disputes between provinces or between provinces and Canada will be submitted to the Federal Court of Canada. But any province faced with a serious problem could change its legislation and thereby revoke the authority of the Court to resolve such disputes. Clearly, an assurance is needed that the accepted rules and procedures for dealing with conflicts are binding on all parties.

A second risk associated with the present situation is that some potentially desirable developments on river systems will be foregone because of the danger they will give rise to litigation.

A third is that projects undertaken on interjurisdictional rivers might proceed without assurance that the legitimate rights of all parties will be respected.

Finally, and importantly, if the matter is left to the courts, the embryonic law governing interjurisdictional waters might be developed in a way that is unsatisfactory to all the governments involved.

All these risks are generating increasing anxiety about the use and development of interjurisdictional waters in Canada, especially among downstream jurisdictions on waterways like those of the Mackenzie

watershed. For all these reasons, we conclude that the status quo is no longer acceptable.

We have also concluded that the federal government should *not* simply legislate federal control over activities in one province that affect the quality, level or flow of water in another province or territory. This would inevitably involve the federal government deeply in regulating waste discharges, withdrawals and projects that are traditionally provincial responsibilities; and it would intrude on provincial responsibilities for property and civil rights as well. Such legislation would, therefore, almost certainly be challenged by the provinces, and it is questionable whether it would be upheld under the peace, order and good government power.

Directions for reform

In the absence of any clear law on this matter, it is impossible to predict how the Federal Court would resolve disputes involving adverse impacts in a downstream jurisdiction from activities in an upstream province or territory. However, we feel confident in drawing two important conclusions from the available evidence and expert legal opinion:

- The Court would most likely reject the view that a province has the right to use water in an interjurisdictional stream without regard to adverse impacts in neighboring jurisdictions.
- The Court would probably recognize a federal government role in interjurisdictional waters.

The legal basis for the latter, beyond matters of navigation and fisheries, is controversial, and the validity of legislation might well depend on its scope. For example, if federal legislation to control pollution on interprovincial rivers interfered with local activities such as sewage treatment, it might not be upheld.

In the absence of federal legislation, the Court would almost certainly recognize some rights on the part of affected jurisdictions, but the nature of these rights and the legal criteria to be adopted in determining them, remain highly uncertain.

We therefore propose a solution to this problem, based on three premises:

First, interjurisdictional problems arising from pollution or regulation of waterways are best solved by agreements between the jurisdictions concerned.

Second, where the jurisdictions involved cannot reach an agreement, federal legislation should provide recourse. But it should intrude as little as possible on provincial jurisdiction, not only to minimize provincial anxieties, but also to ensure that the solution is left as much as possible in the hands of the jurisdictions directly affected.

Third, any federal legislation must be carefully designed to withstand a constitutional challenge.

These considerations lead us to propose federal legislation that would allow intervention to resolve disputes on interjurisdictional rivers only when two prerequisites have been met. First, the relevant governments must have tried and failed to reach an agreement. The *Canada Water Act* has a similar provision.

Second, the problem must have become a major concern to one or more jurisdictions. A complaint from the affected jurisdictions to the federal government could be evidence for this.

The legislation should provide for federal intervention when both these conditions are met. But rather than impose its own solution unilaterally, the federal government should be required to refer the dispute to an interjurisdictional board composed of representatives from each of the governments involved and chaired by a federal appointee. It should then be empowered to make a binding decision based on a majority recommendation from the board.

The formula proposed here should be more acceptable than the existing provisions of the *Canada Water Act* and it will serve a more focused and important function. Therefore, we recommend:

7.6 Part 2 of the *Canada Water Act* should be repealed and replaced with provisions to authorize the federal government to assist in resolving disputes between provinces and territories about the use of interjurisdictional waters. These new provisions should authorize federal intervention where:

i) The provincial or territorial governments have made reasonable efforts to reach agreement and have failed, and

ii) The federal government receives a complaint from one or more affected jurisdictions.

The legislation should provide that, where these conditions are met, the federal resolution of the problem should be based on the recommendations of a board established for this purpose and on which the affected jurisdictions are represented.

We believe that this approach has several advantages. First, it would probably be upheld as constitutionally valid even in a narrow interpretation of the peace, order and good government power. Second, it minimizes federal intrusion by requiring that all other feasible means of resolving the problem be exhausted first. Third, it preserves, as much as possible, the province's role in reaching a solution even when the federal government intervenes.

The need to enact these provisions is urgent for many reasons: The three provinces and two territories sharing the Mackenzie River basin have failed to agree on a voluntary arrangement for managing the river and its tributaries even after some years of negotiation. Upstream projects, both completed and proposed, are causing much anxiety and frustration in downstream jurisdictions. The limited cooperation on rivers that cross the prairie provinces is likely to be a growing concern. These and other festering problems need to be resolved before some unilateral action in an interjurisdictional watershed precipitates an irreconcilable conflict.

Government Organization

The *Government Organization Act* (15) of 1979 explicitly makes the Minister of the Environment responsible for water and for enforcing rules and regulations made by the International Joint Commission. It further directs the Minister to coordinate federal policies and programs concerned with preserving and enhancing the quality of the environment and to ensure that federal projects, programs and activities are assessed for environmental impact. The Act also allows the Minister to initiate programs to promote the establishment of standards relating to environmental quality and pollution control. Finally, the Minister is to provide Canadians with environmental information when it is in the public interest.

Some Limits to Federal Legislation

Water export and drinking water protection are two controversial issues that participants in our public hearings frequently suggested should be the subject of federal legislation.

For many years the federal government has expressed opposition to water export. This position is under pressure today as never before as a result of new proposals for diverting water to the United States and at least one province's interest in exporting water by ocean tanker. The federal government undoubtedly has the constitutional authority to regulate international trade in water, but, apart from the possible relevance of the *International River Improvements Act*, it has never adopted any legislation to control this activity. Chapter 12 deals with this issue.

Canada has no legislated national drinking water standards, and Quebec is the only province that has incorporated such standards into provincial legislation. Other provinces have adopted the guidelines drawn up by a committee of federal and provincial health officials, but they are not legally enforceable. This is considered inadequate by many people, who are alarmed at the proliferation of toxic substances finding their way into community water supplies. We heard frequent calls for federal legislation that would specify and enforce maximum contaminant levels in drinking water. However, the federal government's constitutional authority in health matters is constrained. We return to the matter of drinking water protection in a later chapter.

Finally, the federal government must recognize its specific constitutional responsibility for native peoples, whose treaty and aboriginal rights extend well beyond reserve lands. The government's native claims policy recognizes a native interest in water bodies while regarding water itself as part of the public domain. This position has been incorporated into recent settlements with the Inuvialuit of the western Arctic and with the Cree and Naskapi of the James Bay region. However, until the rights of native people are better defined and until current land claims negotiations and self-government proposals are substantially incorporated into law, it is difficult to comment on their water management implications.

Chapter Eight

International Arrangements

. . . the federal government must carry our case on water issues with our friends to the south.

DEPARTMENT OF ENVIRONMENT AND WORKPLACE SAFETY AND HEALTH
GOVERNMENT OF MANITOBA

The federal government's power to deal with water problems is limited by two kinds of legal constraints: the authority assigned to the provinces by the constitution, which we have already considered, and Canada's legal obligations to the United States under treaties and the principles of international law, which we consider here.

Arrangements With the United States

Major rivers, such as the Columbia, Yukon and Saint John, and most importantly the Great Lakes-St. Lawrence system, are only the more conspicuous of the almost 300 waterways and aquifers that cross or delineate the Canada-United States border. The international dimension of these waterways limits our ability to manage them.

The constraints on government action arise from the formal and informal agreements between Canada and the United States and from restrictions imposed by international law. In general, international law favours a reasonable and equitable sharing of the benefits of international watercourses. It recognizes that no country has the right to use such watercourses without considering the effects on its riparian neighbour. International agreements or treaties between countries supplement, override or modify these general principles of international law. Such agreements are particularly important in Canada because in disputes with the United States, Canada tends to rely on interpretations of these treaties and agreements rather than on general principles of international law. (1)

The Boundary Waters Treaty

Table 8.1 lists the eight significant boundary waters treaties and agreements that influence how we use the watercourses we share with the United States. In addition to these are a few treaties that have some bearing on water management, such as the Migratory Birds Convention of 1916, and a multitude of notes, memoranda of understanding and other less formal accords relating to boundary waters management. Two agreements are of paramount importance and deserve special attention: the longstanding Boundary Waters Treaty and the more recent Great Lakes Water Quality Agreement.

The Boundary Waters Treaty of 1909 established the International Joint Commission and set the basic principles for guiding boundary water relations between Canada and the United States. It settled two troubling problems current at the time: the division of the waters of the St. Mary and Milk rivers on the prairies, and diversions out of the Niagara River for power production (since superseded by the 1950 Niagara River Water Diversion Treaty).

Table 8.1
BOUNDARY WATER TREATIES AND AGREEMENTS

Treaties and Conventions

- Boundary Waters Treaty (1909)
- Lake of the Woods Convention and Protocol (1925)
- Rainy Lake Convention (1940)
- Niagara River Water Diversion Treaty (1950)
- Columbia River Treaty (1961) and Protocol (1964)
- Skagit River Treaty (1984)

Agreements

- St. Lawrence Seaway Project (1952)
- Great Lakes Water Quality Agreement (1972, 1978)

Source: Adapted from Bloomfield, G.M. and Gerald F. Fitzgerald. 1958. *Boundary Waters Problems of Canada and the United States.* Carswell Company Ltd. Toronto. Updated to January 1985.

Of more general significance, the treaty established principles to guide boundary water use and management.

- It entitles Canadian and American commercial shipping to continuing "free and open" navigation of boundary waters — defined as waters that flow *along* the boundary — and of nonboundary Lake Michigan.
- It allows upstream states ". . . exclusive jurisdiction and control over the use and diversion . . . of all waters on its own side of the line which in their natural channels would flow across the boundary or into boundary waters." This principle, known as the Harmon doctrine, was advocated by the United States at the turn of the century. It was qualified in the Treaty by a provision that parties suffering injury in the downstream state would be entitled to the same rights and legal remedies as those injured in the upstream state. The Harmon doctrine, now largely discredited in international law, has not been used by either Canada or the United States to justify its actions.
- It contains an antipollution clause: "Boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other."
- To resolve conflicting demands on shared waters, it establishes a hierarchy of water uses giving primacy to domestic and sanitary use, followed by navigation and then by irrigation and power production.
- It enshrines the principle of equality: the International Joint Commission is to be guided by the precept that each country "shall have, each on its own side of the boundary, equal and similar rights in the use of waters hereinbefore defined as boundary waters."
- Developments on boundary or transboundary waters that will alter the water level along or above the boundary are subject to approval by the International Joint Commission. The two federal governments acting under agreement are exempt from this provision. Also exempt are upstream developments, domestic and sanitary uses and navigation improvements that affect boundary water levels only slightly.

This treaty has served a valuable function in protecting the interest of Canadians in the waters we share with the United States. If we had not had the Boundary Waters Treaty and the International Joint Commission to articulate our water interests during the past 75 years, we would almost certainly have had fewer cooperative projects, less consideration in unilateral developments and more strained relations with the United States. Its principle of equality is particularly important in view of the relative size and power of the two countries. In this respect it is superior to assurances afforded by international law.

Nonetheless, we heard some criticisms of the treaty, the most important of which we give here:

- The treaty is dated in some respects. The priorities it requires the Commission to recognize reflected important values at the time the treaty was negotiated, but they are not attuned to modern social and economic needs. Fisheries and recreation, for example, are ignored altogether. Furthermore the rigid order handicaps the Commission in resolving problems. Indeed, the modern rules of international law governing priorities are more flexible. The Harmon doctrine is also dated, and its inclusion carries the threat that it might be invoked in a future legal crisis.
- The Boundary Waters Treaty does not effectively provide for controlling pollution in the face of modern pressures. While the injunction against pollution is strong, the definition of pollution is vague; so the article fails to provide practical guidance. This inadequacy has been rectified to some extent for the Great Lakes through the Great Lakes Water Quality Agreement, but for other boundary waters the shortcomings remain.

In spite of these shortcomings, the Boundary Waters Treaty has played a valuable role in resolving water problems between Canada and the United States. And many observers believe that as satisfactory a treaty could not be negotiated today. Indeed, a former chairman of the Commission's Canadian section has described the treaty as untouchable. (2)

So, while recognizing these deficiencies, we have concluded that it is not necessary to change the treaty to advance Canada's water interests, and it would be imprudent to do so at the present time.

The International Joint Commission

The International Joint Commission was

the Boundary Waters Treaty's most important institutional innovation. The Commission consists of six members, three appointed by each federal government. The members act, not as representatives under instruction from their governments, but as a single body pursuing what has been described as the "joint or common interest".

The treaty assigns to the Commission two major functions:

- The Commission is responsible for approving and supervising dams and other projects that alter the natural water levels at the boundary or back up water across the border. The Commission performs a quasi-judicial role, setting terms and conditions for compensation and for the project's operation. By 1983 the Commission had dealt with some thirty-two projects involving dams, diversions, obstructions and remedial works.
- The Commission is responsible for conducting investigations and making recommendations regarding questions referred to it by the two governments. Its investigations have prepared the way for, among other things, the Great Lakes Water Quality Agreement of 1972. So far, the Commission has conducted forty-five investigations concerning matters ranging from flow regulation, to water and air pollution, water apportionment and river basin development.

The Boundary Waters Treaty also makes provision for the Commission to arbitrate disputes between Canada and the United States if both countries refer a dispute to it. But this has never been done.

The Commission appoints boards to sort out the information needed to grant approvals and to ensure that conditions of approvals are met. It also forms task forces to conduct the technical work required during investigations. Currently, there are twelve boards supervising dams and other projects along the boundary, six investigative-engineering boards, three pollution advisory boards, and the Great Lakes Water Quality and Science Advisory Boards, formed to help implement the Great Lakes Water Quality Agreement. (See Table 8.2) These boards are staffed primarily by employees of the two federal governments and state and provincial agencies.

Until the 1950s the Commission was involved primarily in orders of approval. It also conducted some major investigations including an early study of boundary waters pollution, and investigated several major projects involving international cooperation, the most notable of which led to development of the Columbia River.

In recent decades, the Commission's investigations have been oriented increasingly toward environmental problems, paticularly regarding the Great Lakes. In 1964, the Commission was asked to investigate two major issues: pollution of the Lower Great Lakes and the levels of the Great Lakes. The pollution study became the basis for the Great Lakes Water Quality Agreement. The Great Lakes levels study has been followed by related investigations resulting most recently in a 1985 Commission report on diversions and consumptive uses.

Other important investigations during the last two decades include the cross-boundary effects of the Garrison Diversion Project in North Dakota and the Poplar power development in Saskatchewan. Most recently, the Commission has been asked to investigate the transboundary implications of coal development in the upper Flathead basin in British Columbia.

Although members of the Commission are appointed by the two federal governments, they have demonstrated a remarkable independence and cooperativeness, and they rarely divide along national lines. The Commission has rewarded the confidence placed in it by the two governments by serving the interests of both countries fairly and equally, by providing sound scientific and technical data, and by working to solve current disputes and to avoid future conflict. Even more importantly, the Commission has proven itself capable of adapting to changing concerns and new responsibilities.

However, its full potential has not been exercised, and thus less is being done than could be done to resolve outstanding problems. The Commission's power of binding arbitration has never been invoked. And in the past several years, when acid rain has been a persistent issue, the governments have not asked the Commission to conduct any investigations. The governments seem reluctant to employ the Commission if they fear the Commission might produce findings to their disadvantage.

Furthermore, the commitment of the Canadian federal government has sometimes been embarrassingly lax. For six months in 1981, two of the three positions for the Canadian commissioners, including

the position of Canadian co-chairman, were vacant; and the Canadian section was not fully appointed until the end of 1982. At this moment of writing, two Canadian positions are again vacant.

Given the complicated problems emerging in continental water systems, we believe that the interests of both Canada and the United States would be advanced through greater use of the Commission to anticipate rather than respond to crises, and to establish principles and approaches for transboundary problem solving. Accordingly, we recommend:

8.1 The Government of Canada should strengthen its support for the International Joint Commission and use its influence to enhance the Commission's stature and authority.

This implies maintaining a full contingent of Canadian commissioners with sufficient experience and expertise to enhance the Commission's reputation. It also implies providing adequate financial, personnel and scientific support to the Commission and its boards. And it suggests using the government's influence to enable the Commission to expand its activities so it can play a more effective role in regulating waters, flows and quality in boundary waters. A number of recent studies on these arrangements offer more detailed suggestions for improvement, which deserve consideration. (3)

The Great Lakes Water Quality Agreement

The Boundary Waters Treaty's simple prohibition against either country inflicting pollution on the other proved to be an unrealistic way of dealing with complicated water quality problems. By the 1960s, the water quality in the Lower Great Lakes had become so degraded that the problem was referred to the International Joint Commission. Its 1970

Table 8.2
CANADA — UNITED STATES WATER BOARDS

Reporting to the International Joint Commission	Reporting Directly to Governments
Boards of Control	
Columbia River	Columbia River Permanent Engineering Board (Treaty)
Kootenay Lake	
Lake Champlain	Lake Memphramagog Board
Lake of the Woods	Niagara River Committee (Treaty)
Lake Superior	Niagara River Toxics Committee
Niagara River	Poplar River Bilateral Monitoring Committee
Osoyoos Lake	
Rainy Lake	Saint John Water Quality Committee
St. Croix River	
St. Lawrence River	
St. Mary-Milk Rivers	
Souris River	
Investigative-Engineering Boards	
Flathead River	
Great Lakes Diversion & Consumptive Uses	
Great Lakes Levels Advisory	
Lake Erie Regulation	
Souris and Red Rivers	
Technical Information Network	
Pollution Advisory Boards	
Rainy River	
Red River	
St. Croix River	
Great Lakes Water Quality Agreement Boards	
Great Lakes Water Quality	
Great Lakes Science Advisory	

Source: International Joint Commission. 1983. *Report to December 31, 1982.* Updated to January 1985.

report persuaded the two governments that immediate action was needed to abate pollution in the Great Lakes Basin. Subsequently, Canada and the United States signed the first Great Lakes Water Quality Agreement in 1972.

The agreement goes much further than the Boundary Waters Treaty in setting out what should be done about pollution. It prescribes standards designed to achieve certain water quality objectives; it specifies remedial programs to improve water quality; and it gives the International Joint Commission authority to monitor progress. It also provided for two new references to the Commission dealing with pollution from land uses and water quality in the upper Great Lakes.

The agreement's immediate concern was eutrophication (overenrichment) of the Great Lakes from municipal sewage. Although the sewage treatment program progressed more slowly than planned in the United States, by 1979, reports indicated substantial progress in phosphate reduction.

The agreement called for a review after five years, which resulted in an amended agreement in 1978. It gives much more emphasis to industrial pollutants, toxic substances and radioactive wastes, and sets water quality objectives for about thirty chemicals. It commits Canada and the United States to virtually eliminate discharges of persistent toxic substances and to establish early warning systems to anticipate problems associated with toxic substances. It also provides for further reduction in phosphorus loadings for each of the Lakes. The general objectives of the new agreement apply to the entire Great Lakes system (not just to boundary waters).

In its first biennial report, in 1982, the Commission found that substantial progress had been made in reversing the advance of eutrophication in Lakes Erie and Ontario, but no significant progress had been made in identifying or reducing toxic substances. The second biennial report, in 1984, confirmed the progress in controlling phosphorus and other conventional pollutants with some reservations about the performance of municipal treatment plants and pollutants from land runoff. It reported only limited progress regarding the control of toxic substances. (4) Progress is impeded because the agreement concentrates on establishing objectives for individual toxic substances rather than on a comprehensive strategy for managing the Lakes' ecological regime, which would take account of the cumulative effects of pollution from all sources over an extended period.

While the agreement addresses more realistically than the Boundary Waters Treaty the problem of pollution, unlike the treaty, it does not empower the two governments to enforce the terms on other levels of government or on the private sector. In the United States, treaties become domestic law, while agreements reflect only the intentions of the government and impose no legal requirements on individuals, business or other levels of government. So, successful implementation depends on federal legislation designed for nation-wide application. In Canada, the agreement is supported by federal agreement with Ontario, which is responsible for water management. So, successful Canadian implementation depends on Ontario enforcement.

Potential Developments

The growing pressures on our international waterways have stimulated interests in a variety of measures to strengthen cooperation outside the mechanism of the International Joint Commission. This year, the eight states and two provinces that share access to the Great Lakes system signed an accord opposing any diversion of Great Lakes water out of the basin. Although not formally binding on the federal governments, it may have significant influence, not only on the future development of the lakes, but also on future cooperative arrangements.

While recognizing the importance of such agreements between Canada and the United States, we also recognize that these are only a part of the picture. Governments respond to political pressures and in our societies the strongest pressures come from within, not from neighboring countries. International arrangements encourage recognition of international obligations and provide mechanisms to reconcile conflicts of interest, but they depend on the will of both countries to make use of them. For important issues, such as toxic pollutants and acid rain, we have failed to generate recognition of a common interest, which is essential for cooperative remedial action.

Experience with the Great Lakes Water Quality Agreement has produced suggestions that Canadian management of the

Great Lakes demands more effective and reliable working arrangements among Ontario, Quebec and the federal government. A natural extension of this is found in current proposals for an international body with authority to manage the whole Great Lakes system. While this suggestion focuses on the Great Lakes, some commentators have pointed to the need, in all of Canada, for improved working arrangements between the federal and provincial governments regarding international waters and agreements affecting them.

We feel that these and other ideas deserve careful consideration: our institutional arrangements for managing international waters could no doubt be improved, and the federal government should be receptive to new approaches.

Other International Activities

Canada's international interests in water extend beyond relations with the United States. Canada participates in the work of a number of international organizations that have an interest directly in water development and management or indirectly in the monitoring, research, technology development, law, or policy that supports these activities: the United Nations Environment Programme, World Meteorological Organization, World Health Organization, Economic Commission for Europe, United Nations, International Maritime Organization, the North Atlantic Treaty Organization and the Organization for Economic Cooperation and Development.

Much international activity is directed at providing financial and technical assistance for third world development. Canada does this directly through the Canadian International Development Agency and other nongovernmental organizations, and indirectly through the United Nations and other multinational development agencies.

Some activities are directed at creating international conventions and treaties, which may be translated into Canadian legislation. Other activities aim to promote the development of international law and policy in the water resources and environmental area. The Organization for Economic Cooperation and Development is involved in developing environmental policies appropriate to industrialized countries and the implications of environmental policies for international trade. These activities are only indirectly concerned with the management of Canadian water resources, so they are beyond this inquiry's terms of reference.

Part IV
Policies and Programs

PART IV
POLICIES AND PROGRAMS

In Part IV we examine the breadth and complexity of water management issues. Current policies and programs are reviewed and new approaches to management and conservation are proposed.

Chapter 9 provides a description of the range and variety of federal government programs concerned with inland waters. To complete the overview of water management in Canada, the activities of provincial and territorial governments are outlined briefly. In Chapter 10 we assess these federal programs and resources and make recommendations for reorienting them to improve water management. Chapter 11 is devoted to the water-related research effort of the federal government and emphasizes the need to maintain adequate support for national data collection and both basic and applied research. Chapter 12 turns to the question of water export and the need to establish a general policy for dealing with export proposals.

Chapter Nine

Programs and Resources

Realistically this is the time for resolve. Through this resolve commitments of the limited available resources can be made to address real concerns.

LAMBTON INDUSTRIAL SOCIETY

This chapter outlines the federal programs, expenditures and personnel devoted to freshwater matters. We also outline the parallel and complementary activities of provincial and territorial governments to provide the needed context for assessing federal programs in the following chapter.

Compiling a comprehensive account of federal water-related activities has been difficult. As noted in Chapter 2, federal water policy has evolved in response to changing economic and political circumstances; as a result, many departments administer a diversity of programs and funding arrangements.

No central record exists of resources devoted to water-related activities. So we have drawn our information from departmental budgets, from program descriptions in 1985/86 budget estimates, and from information contained in annual reports and discussions with officials. (1) Because of differences in accounting and reporting systems among departments, our summary of resources expended on various programs cannot be considered precise, but we believe it reasonably indicates the orders of magnitude involved.

Federal Resources Devoted to Water Programs

We estimate the total resources committed to freshwater matters by the federal government to be about $373 million and 3,540 person years in 1985/86. (See Figure 9.1) Table 9.1 summarizes the distribution of this effort among departments.

Environment Canada accounts for 45 percent of the total federal commitment. This department devotes 23 percent of its budget to water-related programs, amounting to $169 million and 1,880 person years.

Other departments that make significant expenditures on freshwater activities include Fisheries and Oceans, Indian Affairs and Northern Development, Transport, Public Works, Agriculture, Energy, Mines and Resources and External Affairs, including the Canadian section of the International Joint Commission. Fisheries and Oceans allocates about 10 percent of its total budget to water-related programs. The other departments devote less than 3 percent of their budgets to such activities.

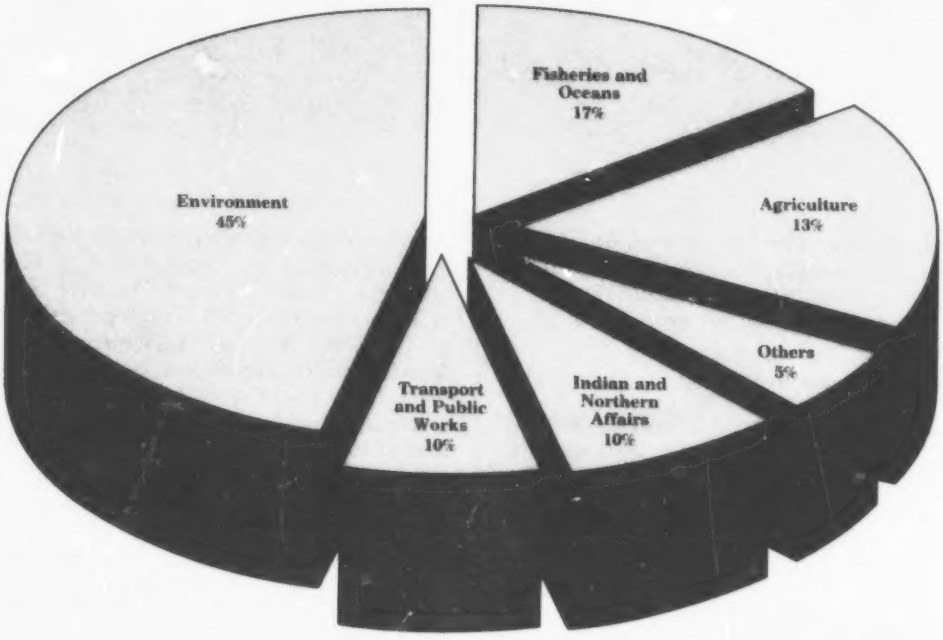
Table 9.2 summarizes the distribution of these federal resources among programs and services. It shows that research and

Table 9.1
FEDERAL RESOURCES DIRECTED TO WATER-RELATED PROGRAMS BY DEPARTMENT, FISCAL YEAR 1985-86

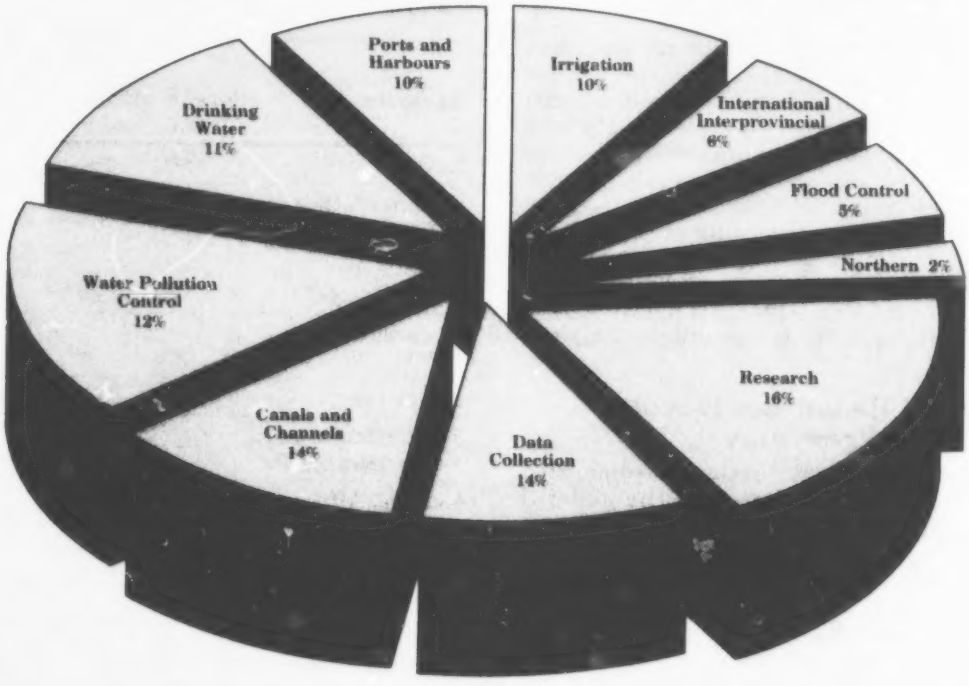
Agencies	Person Years	Expenditures Millions of $	Expenditures % of Total
Environment	1,880	169	45
Fisheries & Oceans	620	62	17
Indian Affairs and Northern Development	60	39	10
Transport and Public Works	270	37	10
Agriculture	545	50	13
Energy, Mines and Resources	80	8	3
External Affairs	25	4	1
International Joint Commission	45	3	1
Other	15	1	—
TOTAL	**3,540**	**373**	**100**

Source: Adapted from Treasury Board. 1985. *1985-86 Estimates Part III* (for the various departments). Supply and Services Canada, Ottawa.

Figure 9.1
ADMINISTRATIVE ORGANIZATION AND SUPPORT



Federal Water Sector Expenses by Department



Federal Water Sector Expenses by Program

INQUIRY ON FEDERAL WATER POLICY

Prepared by Drafting Division, EOS

Source: Adapted from Treasury Board of Canada. 1985. *Estimates 1984-85, Part III*. Ottawa.

data collection account for 30 percent of water-related spending. Navigation and ports, and water quality programs, each account for about 23 percent.

These data include overhead and capital costs as well as the operational cost of programs. We have tried to include expenses related to the preservation and development of water resources, but not expenses associated with the management of particular resource uses. For example, expenditures on water pollution control and fish habitat protection are included, but the cost of managing fisheries is excluded.

Table 9.2 does not include some water-related programs we discuss later in this report because their associated costs are minor. Also excluded are the Canadian Heritage Rivers System agreements, which account for expenditures of less than $200 thousand in federal funds.

The categories of programs and services we use in the table are somewhat artificial, since some programs are directed toward more than one purpose, such as research and pollution control. We have depended on judgement and assumptions in allocating such expenditures among the categories.

The acid rain program illustrates the difficulty in categorizing expenditures. That program has two components: grants for pollution control equipment and grants for research. The $150 million earmarked for the former was not included in the 1985/86 estimates of any department, though it will be expended before 1994. The $150 million earmarked for research is to be spent at the rate of about $18 million per year for the next eight years. A portion of these funds, which are directed not only at water, is reflected in the estimates of several departments.

Research

The constitution does not mention research and data collection, but they appear to be covered by the "census and statistics" power it assigns to the federal government. Federal legislation providing for research in water includes the *Canada Water Act*, *Fisheries Act*, *Environmental Contaminants Act*, *Pest Control Products Act* and the *International Boundary Waters Treaty Act*. International and federal-provincial agreements, such as the Great Lakes Water Quality Agreement, often specify requirements for federal research as well.

Much of the water research carried out by federal agencies supports federal management programs and responsibilities; but the federal government also provides funds for basic scientific investigations in federal research institutes, universities, provincial agencies and private organizations.

Environment Canada and Fisheries and Oceans Canada sponsor most water-related research. But Energy, Mines and Resources, Agriculture, Health and Welfare, Indian Affairs and Northern Development, and the National Research Council also conduct investigations into various water problems.

The federal budget estimates for 1985/86 allocate some 725 person years and $60 million for water-related research. Of the total expenditure, two-thirds is expended directly; the rest is allocated through grants, contracts and contributions to external research agencies and individual researchers. (Granting programs are examined in Chapter 11)

Data Collection

The federal government has become involved in a wide range of data collection activities related to water. The *Canada Water Act* authorizes Environment Canada to collect data related to water and, in particular to collaborate with the provinces for this purpose. The *Fisheries Act* authorizes Fisheries and Oceans to collect water data related to fisheries. The *Canada Shipping Act* authorizes Fisheries and Oceans to conduct hydrographic surveys.

Environment Canada collects, analyzes and distributes data on such matters as lake levels, river discharges, sediment, water quality and uses through programs described in Chapter 11. The provinces contribute to the operation of the water quantity monitoring network under federal-provincial agreements.

Fisheries and Oceans conducts hydrographic surveys and produces charts, tide and current tables and other publications. These include data for the Great Lakes and estuaries.

Federal funding for these freshwater data programs and services amounts to about $54 million annually, of which $36 million comes from Environment Canada and $14 million from Fisheries and Oceans. Some 750 person years are directed to these activities including 520 from Environment Canada, 180 from Fisheries and Oceans and the

remainder from Energy, Mines and Resources.

Pollution Control

Both the federal and provincial governments have responsibilities in water pollution control. Environment Canada's mandate for pollution control is based on the *Canada Water Act*, which provides for federal pollution control activities in collaboration with the provinces; the *Environmental Contaminants Act* and Section 33 of the *Fisheries Act*, which give the department more specific authority to deal with certain kinds of pollution; and the *Government Organization Act*, which gives the department a general responsibility for promoting the quality of the environment.

Fisheries and Oceans depends on the *Fisheries Act* to protect fish habitat. Transport Canada administers the *Canada Shipping Act*, which provides for controlling pollution from ships. The Department of Indian Affairs and Northern Development is responsible for pollution control in the northern territories under the authority of the *Northern Inland Waters Act*.

Federal activities in water pollution control are only a fraction of the total Canadian effort in this field, since the provincial governments administer most regulations. Environment Canada's pollution control activities are intended to support provincial and territorial programs for protecting the aquatic environment in the interests of human health, natural ecosystems, and sustained water resource uses. The department's activities in this field include site inspection, sample analysis, technology development, environmental emergency

Table 9.2
FEDERAL RESOURCES DIRECTED TO WATER-RELATED PROGRAMS BY TYPE OF PROGRAM, FISCAL YEAR 1985-86

Program	Agencies	Person Years		Expenditures	
		Number	% of Total	Millions of $	% of Total
water research	Environment, Fisheries & Oceans	725	20	60	16
water data collection	Environment, Fisheries & Oceans	750	21	54	14
water pollution control	Environment, Fisheries & Oceans	630	18	44	12
drinking water	Agriculture, Indian Affairs and Northern Development, Health & Welfare	10	—	41	11
canals and channels	Environment, Transport, Public Works	420	12	51	14
ports and harbors	Fisheries & Oceans, Transport	60	2	36	10
irrigation	Agriculture	500	14	38	10
flood control	Environment, Transport	160	5	18	5
	Environment, External Affairs, International Joint Commission	230	6	24	6
	Indian Affairs and Northern Development	55	2	7	2

Source: Adapted from Treasury Board. 1985. *1985-86 Estimates Part III* (for the various departments). Supply and Services Canada, Ottawa.

coordination and implementing the industrial effluent regulations under Section 33 of the *Fisheries Act*. And its efforts are directed toward particular problems, such as toxic chemicals, acid rain, and the water quality in the Great Lakes. Environment Canada currently devotes some 470 person years and $35 million to this effort.

Fisheries and Oceans' effort is directed toward protecting fish habitat from degradation. Though this is only a part of a much larger fisheries management program, it devotes a significant part of its budget to this effort.

Our data exclude Transport Canada's expenditures under the *Canada Shipping Act* for inland waters, and the funds allocated by the Department of Indians Affairs and Northern Development to pollution control. These probably amount to less than a million dollars.

Drinking Water

The federal and provincial governments have agreed on water quality guidelines for some water uses, including human consumption. Provincial governments are responsible for ensuring potable water supplies, though they usually delegate this responsibility to regional medical health officers. Nevertheless, the federal government has some responsibility for potable water in certain circumstances, and this gives rise to significant expenditures.

Under the authority of the *Indian and Northern Affairs Act*, the Department of Indian Affairs and Northern Development currently allocates about $32 million annually and six person years to providing drinking water on Indian reserves. The Prairie Farm Rehabilitation Administration expends $9 million on farm domestic water supplies.

National Health and Welfare employs about three person years to inspect potable water supplies in areas related to federal responsibilities, for example on international and interprovincial carriers. Parks Canada supplies water for national parks. Armed forces bases and other federal facilities must obtain water supplies where they are not provided by municipal water systems, but we have no estimates of the costs.

Altogether, the federal resources devoted to drinking water supplies for which we have information amount to $41 million and about ten person years.

Navigation and Ports

The federal government provides for most of the navigation and port facilities in Canada under its constitutional responsibilities for navigation and fisheries.

The *Canada Shipping Act* and the *Department of Transport Act* authorize Transport Canada to develop and maintain shipping facilities including channels, canals and ports. Accordingly, Transport Canada and related agencies operate the major Canadian commercial shipping ports as well as a few smaller ports serving isolated communities. The department is also responsible for managing dredging in support of commercial navigation. In addition, the Canada Ports Corporation and individual port authorities operate some ports. Fisheries and Oceans Canada operates some small craft harbours, used primarily by commercial fisherman. And Parks Canada, under agreements with provinces, maintains and operates a number of heritage canals.

Altogether, some $87 million and 480 person years are allocated to navigation and port facilities in inland waters. Of this, $20million and 150 person years are for sounding and dredging, $2 million for locks and dams on the Ottawa, French and Red rivers, and $29 million and 270 person years for constructing and maintaining heritage canal facilities.

Irrigation

The *Prairie Farm Rehabilitation Act* authorizes the federal government to become involved in irrigation and farm water supply systems. As well, the Economic and Regional Development Agreements between the federal government and both Saskatchewan and Manitoba provide for joint water development and drought proofing programs. Under these agreements, the federal government supports improving water management, analyzing the supply and demand for water, investigating drought sensitivity, and providing water supplies and delivery systems.

Agriculture Canada supports programs for rural soil and water conservation and for developing water resources for agriculture. Most of these are administered on the prairies through the Prairie Farm Rehabilitation Administration. Its programs range from providing small water sources on individual farms to developing large-scale district irri-

gation systems. Its South Saskatchewan River Project irrigates about 14 thousand hectares. It is also responsible for rehabilitating the Bow River Valley reservoirs and related aqueducts although Alberta has assumed their ownership. The Prairie Farm Rehabilitation Administration also provides engineering and planning services to the provinces to assist them in developing long-term water supply and drought proofing programs.

Twenty-six dams were constructed under these arrangements, twenty-three of which the Prairie Farm Rehabilitation Administration operates. The dams provide irrigation water for some 19 thousand hectares. It also operates the Gardiner and Summit dams at the expense of the Province of Saskatchewan.

We estimate the federal expenditures on agricultural water programs to be $38 million and 500 person years. These figures include all allocations for water resource development and half the Prairie Farm Rehabilitation Administration's budget for rural soil and water conservation.

Under the Canada-Saskatchewan Subsidiary Agreement on Agricultural Community Water Infrastructure, some forty-two agricultural centers will be established. The agreement provides for $32 million to be expended over the next five years, of which $16 million will be recovered from the province. Under other subsidiary agreements, $23 million and $30 million, respectively, will be expended over the next five years in Manitoba and Saskatchewan.

Flood Control

The *Canada Water Act* authorizes Environment Canada to mitigate human suffering and losses due to flooding and to take measures to reduce flood damage in cooperation with provinces and territories. The government contributes to relief from floods and other disasters through cost-sharing arrangements with provinces. The formula for sharing costs takes into account the population of the province and the damage eligible for assistance.

It has also implemented flood control programs in many regions of Canada. Since 1975, federal activities have been directed toward discouraging development on flood plains to reduce flood losses. This has entailed mapping and designating flood risk areas, discouraging developments in those areas, and undertaking some structural projects, all under agreements with provinces and territories.

At present, the Northwest Territories and all provinces except Alberta, British Columbia and Prince Edward Island participate in the flood damage reduction program. A memorandum of understanding between the Department of Indian Affairs and Northern Development and Environment Canada ensures that Indian reserve lands are included in this program as well. Included in our estimate is the dyke construction in the lower Fraser Valley of British Columbia that predates the flood damage reduction program and which is proceeding under an agreement with the federal government.

Transport Canada undertakes ice breaking in the St. Lawrence River below Montreal to prevent flooding that may result from ice buildup and ice jams.

Environment Canada's expenditures under the flood damage reduction program have been decreasing, and are forecast at about $9 million for 1985/86. Transport Canada consistently spends about $9 million annually on ice-breaking operations. The figures presented in Table 9.2 exclude the unpredictable costs of flood disaster relief.

International and Interprovincial Waters

As explained in the preceding chapter, the federal government is responsible for arrangements with the United States relating to international waters. The *International Boundary Waters Treaty Act* and the *International River Improvements Act* supplement this general constitutional authority. Under agreements with provinces, the federal government is also involved in managing interjurisdictional waters within Canada.

Environment Canada and other federal agencies provide staff and support to twenty-three control boards and study committees of the International Joint Commission. The department is also responsible for nineteen federal-provincial agreements for managing and resolving issues on interprovincial waters. And negotiations on water quality objectives involve the department in both international and interprovincial waters. External Affairs

Canada is responsible for the international arrangements.

Of the $24 million and 230 person years accorded to these activities in Table 9.2, Environment Canada contributes $17 million and 160 person years to international and interjurisdictional water management.

External Affairs Canada estimates that it directs about $4 million and twenty-five person years to water-related relations with the United States. The International Joint Commission is currently allocated a budget of about $3 million and forty-five person years. This includes the resources of the Canadian secretariat in Ottawa and the Canadian share of the Great Lakes Regional Office, but not the resources of Environment Canada and other departments allocated to the commission's boards and committees.

The largest item of federal expenditure in this category is the Great Lakes Water Quality Agreement, which accounts for nearly $10 million.

Northern Water Administration

The Department of Indian Affairs and Northern Development administers most of the federal government's general responsibilities for managing lands and resources in Yukon and the Northwest Territories. The *Northern Inland Waters Act* provides the statutory framework.

Part V describes the administration of water resources in the northern territories. Activities include issuing licences for water use and waste discharges, enforcing the terms and conditions of licences, resource planning, monitoring water quantity and quality and a wide range of other water management activities.

The Department of Indian Affairs and Northern Development estimates expenditures of $7 million on water resource management in the north in 1985/86. This includes about $600 thousand for the territorial water boards. Some of the federal transfer payments made to the territorial governments may be expended on water as well, but we have made no allowance for this in our estimates.

Other Activities

Some other water-related activities that involve relatively small federal expenditures are excluded from our summary in Table 9.2. For example, Health and Welfare Canada's expenditures on its responsibilities for the quality of drinking water and control of chemical hazards are excluded, as are federal funds devoted to the Canadian Heritage Rivers System agreements and the federal funds for projects involving water under the Economic and Regional Development Agreements.

Statistics Canada cooperates with and assists water agencies in collecting data through various surveys. Certain departments, including Health and Welfare, External Affairs and Environment participate in activities of multilateral organizations, such as the Organization for Economic Cooperation and Development, and various United Nations' agencies that are sometimes concerned with water. The Canadian International Development Agency and Environment Canada collaborate on water-related programs in underdeveloped countries, particularly those related to the United Nations' clean water and sanitation decade.

Provincial Water Management

As we explained in Chapter 6, general responsibility for managing water in Canada rests with the provinces, though provincial authority is constrained by several constitutional powers of the federal government. These restrictions limit provincial authority over nearly all significant bodies of water.

We sketch here the wide responsibilities of provincial governments in managing water. We do so for two reasons. First, the appropriate scope of federal activities can be assessed only within the total context of water management responsibilities in Canada. Second, we propose in later chapters that the federal government invite provincial governments to participate in joint programs. This calls for an understanding of provincial responsibilities and policies.

Provincial Management of Water Uses

Generally, provincial management of water uses has its origin in common law. (2) Riparian rights do not allow water ownership, but they provide a landowner with the right of access to water that abuts his land, the right to fish, the right to receive the water flowing past undiminished in quantity and quality and the opportunity to take action against those who interfere with these rights. This

implies a corresponding obligation to respect the rights of downstream riparians. (3) It also implies that anyone who does not own land abutting a watercourse has no opportunity to use the water. Property ownership is deemed to extend to the middle of the streambed. These rights, except for the right to fish, cannot be transferred without transferring the land to which the rights apply.

With economic growth and industrialization, all jurisdictions in Canada have recognized the inappropriateness of common law riparian rights, and replaced most of them with statutory law. In the older jurisdictions of Ontario and the Atlantic provinces, the modifications have been piecemeal, resulting in hybrid combinations of common and statute law. In the western provinces, Yukon and the Northwest Territories, the statutory modifications have virtually displaced the common law rules. In most provinces, ownership of rights to water are vested in the provincial Crown; water is not owned, but its use is regulated under statutes that set out systems of water rights. (4)

All provinces require permits or licences to withdraw water, except for that withdrawn for domestic purposes. Licensed uses include irrigation, hydroelectric developments, municipal and industrial water supplies, but rarely include instream uses such as navigation, recreation and wildlife habitat.

Some legislation sets out priorities for distributing water among uses when water is scarce. Typically it gives top priority to domestic and municipal uses, followed by industrial and irrigation uses. One province specifically puts diverting water for these purposes ahead of other uses such as impounding or diverting water for instream purposes. (4)

Generally, licences issued first take precedence over licences issued later when flows are insufficient to meet all needs. However, if a licence is for a higher priority use, the licensee can apply to have an earlier licence cancelled. If an earlier licence is cancelled, the licensee must be compensated. Although this provision has apparently been litte used, it may become more important as demands grow.

Licensing processes vary somewhat from province to province. Sometimes a posted notice and a public hearing are required before an application for a licence or permit is considered, but in many cases public hearings are waived if no objections are received. Usually, an interim or conditional licence is approved subject to the interests of downstream licence holders unless all the available water has been allocated previously. When a project has been completed and inspected, a final licence is issued. The final licence typically sets out the appurtenant land, the authorized use or nature of the work and the authorized flows.

Licences may have an indefinite period and may be cancelled if they are not exercised. In at least one province the water licence is attached to land and is transferred when the land is transferred. In virtually all cases the licensing authority can revoke or alter a permit as it sees fit. (4)

Some provinces are concerned about sharing and conserving groundwater, and require permits or licences for its withdrawal. All provinces license well-drilling activity and sometimes regulate the drilling method. (5)

Water power development is governed by special legislation in several provinces. In at least two, major developments must be ratified by the provincial legislature. The development might also require the approval of various energy or utility boards. (4)

Other resource legislation sometimes applies to water use; for example, various land acts require an environmental impact assessment where a proposed project would disrupt land or water.

Organizational arrangements also vary among provinces. In several, one ministry supervises planning, development, allocation and management, while another is responsible for water quality and pollution control. In one case, a crown corporation and a line department share responsibilities. (6) In others a single department is responsible for most aspects of water management. At least one province has a water comptroller responsible for licensing. Agricultural departments may also be involved in water-related activities directed to farm assistance and land.

The water management policies of some provinces embody principles consistent with those we advocated at the beginning of our report. Alberta and Saskatchewan both provide examples of watershed management and public involvement. Alberta manages water resources according to six

major watersheds (5), and public hearings on the first comprehensive basin plan for the South Saskatchewan River have just been completed. Saskatchewan's new Water Corporation has, like Alberta, divided the province into six watershed management regions with regional advisory boards of local people to assist in setting priorities. (6)

Local users manage irrigation districts in Alberta, and landowners in Saskatchewan have formed water users' associations to manage common drainage areas or irrigation districts. (6) Ontario supports thirty-nine conservation authorities created at the petition of two or more municipalities (7), whose scope may extend to entire watersheds. The municipalities appoint board members, who have broad powers to study the watershed and to design programs to preserve, restore and manage its natural resources. Manitoba also provides for local conservation boards to manage resources and to promote conservation in watersheds.

In addition to these management boards and advisory committees, various commissions and panels have been set up to hold public hearings and to investigate and regulate activities or projects that may affect the environment generally or water in particular. Some are more elaborate, more mature and have greater authority than others. However, some provinces award water use licenses and discharge permits, undertake strategic planning and develop projects without significant public involvement. (8)

Provincial Water Quality Management

To manage water quality, most provinces regulate waste discharges, water works, sewage works and effluent concentrations, among other things. They also license water and sewage plant operators, specify operating standards for water and sewage works, and control the quality of receiving waters.

To coordinate pollution control activities, seven of the ten provinces have signed accords with the federal government. These accords provide a broad framework for administrative cooperation. The federal government agrees to establish national ambient water quality objectives pursuant to the *Fisheries Act*, to develop national baseline standards and guidelines for effluents and emissions in consultation with the provinces and industry, and to set requirements for particular industrial sectors.

Under the accords, the governments agree to identify water quality objectives for specific areas of joint interest, to control pollution to meet these objectives, to enforce the national effluent standards, to cooperate in monitoring and surveying the environment and exchanging information, and to consult about potential environmental implications of major development proposals. The provinces undertake to establish and enforce effluent standards at least as stringent as the national baseline standards to all *new* installations and to all *existing* installations as soon as practicable. (They sometimes specify areas where the water quality must meet higher standards than the objectives.) The provinces also take responsibility for ensuring that permit holders comply with the terms of discharge permits, which require that the ambient water quality objectives be met.

Under these arrangements, most provinces have established water quality objectives which consist of narrative or numerical criteria for protecting aquatic life and water recreation. They represent the desired quality of water that the province strives to maintain. (9) Water quality for specific pollutants are determined with reference to concentrations that cause specified rates of mortality in some test organism, such as lake trout.

Discharge permits usually contain site specific regulations that limit concentrations of suspended solids, substances that increase biochemical oxygen demand, toxic contaminants, and substances that affect color.

Many provinces set quality objectives for water used for paticular purposes, such as drinking, recreation, fish and wildlife, irrigation, livestock watering and industrial uses. Objectives are sometimes designed to meet the requirements of the International Joint Commission.

All these water quality controls are complicated and difficult to administer, but the major weakness seems to be in surveillance and enforcement. And, in some provinces, inadequate staff has impeded full implementation of the accords.

Conclusion

The federal government now commits an estimated $373 million and 3,540 person

years, annually, to water management. This commitment's adequacy can be properly assessed only within the context of provincial and federal responsibilities in water management. In this chapter we have reviewed the closely related activities of the two orders of government and noted some attempts at cooperative water management.

Chapter Ten
Water Management for the Future

Whether lifestyles will be diminished in the face of growing water demands, or whether a continued increase in enjoyment and productivity can be sustained, will depend upon how we manage this essential resource.

CANADA WEST FOUNDATION

The ultimate objective of water management in Canada, as our terms of reference suggest, must be to ensure that the potential contribution of water resources to the social and economic well-being of Canadians will be realized. This implies that Canadians must continue to have access to sufficient, safe and sustainable water supplies.

In the preceding chapter we described the variety of programs that the federal government has developed to contribute to water management in Canada. The range of agencies, and the total resources involved in these programs are considerable. We also outlined, in a general way, how provinces and territories manage water resources. In this chapter we consider ways federal water programs could be reoriented to enable them to contribute more effectively to overall management objectives in the face of the new and emerging problems discussed in Part II.

We begin by suggesting some basic approaches to the federal government's role in water management. These build on the principles we set out in Chapter 1. In the remainder of the chapter we suggest how these prescriptions could be incorporated into particular programs.

Some Basic Approaches

Our recommendations reflect the principle that the river basin or watershed is usually the most appropriate unit for water management. This entails recognizing the interdependence of watercourse uses and the relationship between land and water development. Though integrated watershed management has many impediments, including insufficient data, divided jurisdictions and administrative difficulties, it is an appropriate objective for water policy.

We also believe that water management should be based on a judicious balance between managing supplies and managing demands. Thus, opportunities for conserving water and using it more efficiently must be considered as alternatives to developing new supplies. To motivate efficient use and to distribute costs equitably, we believe that users should pay a price for using water that takes into account its value and the cost of supplying it.

Water projects should always be carefully analyzed to ensure that the benefits exceed the costs. This requires systematic and consistent assessments that take into account social and environmental impacts as well as direct economic costs and benefits. Environmental risks, the implications of irreversible decisions, and the intrinsic value of preserving natural water regimes should also be recognized.

Our proposals also reflect our conviction that modern resource management must provide for effective public participation in major decisions.

In addition to these general principles for managing water, we believe that federal water policy development should be guided by certain basic considerations. First, federal activities must respect the constitution's division of responsibilities. Second, given the interrelationship between those divided responsibilities, the federal government should seek to reconcile and harmonize its programs with those of provincial and territorial governments. Third, the federal government should ensure that its own programs and services are available to all Canadians equitably, while recognizing differing regional needs and circumstances. Fourth, federal water-related programs should be coordinated and administered efficiently. And finally, federal policies should promote the development of scientific knowledge and expertise, technical understanding and public awareness about

water resources and management problems in Canada.

Watershed Management

The watershed, or drainage basin of a river and its tributaries, was mentioned frequently during our public hearings as the appropriate geographical unit for water management. The obvious attraction of the basin is its unity of natural processes, and the interdependence of uses within it. Interrelationships between upstream and downstream events on a river, and among users around a lake, can be identified and the costs and benefits of development can be shared more equitably on a watershed basis than when artificial boundaries separate the interests of those affected.

Many advocates of management on a watershed basis see it as an opportunity for dealing with water issues at the local level. Indeed, the stimulus for many local interest groups comes from experiences in their watersheds.

Ontario established the first of its thirty-nine watershed-based conservation authorities in 1946. Located in the small and more densely populated watersheds, these agencies support numerous programs in flood and erosion control, water quality improvement, forestry, wildlife and education. Conservation authorities spend almost $100 million annually, of which 40 percent is raised in levies from municipalities located within authority areas. (1)

Manitoba has several districts for soil and water conservation, which are organized largely by watershed. Both Alberta and Saskatchewan are divided into major river basin regions, each with a regional manager and planning staff. Alberta completed its five-year South Saskatchewan Basin Planning Program with public hearings in 1984.

In 1967, the federal government promoted comprehensive basinwide planning of water and related resources by offering to fund federal-provincial basin studies in each of Canada's major regions. Over the next few years, planning agreements were signed for the Saint John, Qu'Appelle and Okanagan basins providing for studies on a cooperative, cost-shared basis consistent with the terms of the 1970 *Canada Water Act*. During the 1970s, the Churchill, Souris, Shubenacadie-Stewiacke, Mackenzie and Yukon river basins were subjects of intergovernment investigations. Most of these were planning studies, a few resulted in implementation agreements but in most cases no formal arrangements have been made for updating basin plans. No new intergovernmental basin investigations have been negotiated since 1981.

Experience with river basin planning in the United States is similar to that in Canada. In the 1960s, several federal-state commissions were established to design comprehensive master plans for the development of major river basins. These multi-jurisdictional bodies proved to be unwieldy, they antagonized existing governmental agencies, which had their own mandates and interests, and they were abolished by presidential order in 1981. State-sponsored advisory bodies are now attempting to provide consultation and exchanges of information for these basins without federal participation.

In both countries, many local groups have been formed to influence particular projects or to draw attention to watershed needs. Examples include the Nechako River Task Force in British Columbia and the International Coalition for Land and Water Stewardship in the Red River Basin of Minnesota, North Dakota and Manitoba.

Canada, the United States and other western countries have already had substantial experience in watershed management, and a considerable literature now exists on the subject. This provides valuable guidance for successful watershed management and suggests that, ideally, it should incorporate the following features:

- a watershed plan sufficiently comprehensive to take into account all uses of the water system and other activities that affect water flow and quality characteristics to provide a reference for management;
- information about the watershed's full hydrological regime;
- an analytical system, or model, capable of revealing the full range of impacts that would be produced by particular uses and developments in the watershed;
- specified management objectives for the watershed, with criteria for assessing management alternatives in an objective and unbiased way;
- participation or cooperation of all relevant regulatory agencies;
- provisions for public participation in determining objectives and in management decisions.

The practical difficulties in developing a management system with all these features are formidable: for large river basins, the organizational effort and data requirements are costly; for divided jurisdictions, the separate responsibilities of governmental departments and agencies present barriers to cooperation and agreement on common objectives and methods; for watersheds that experience significant pressures and conflicts, such sophisticated plans lack sufficient relevance; and, in the absence of urgent problems, interest may be insufficient to motivate organized public participation. For such reasons, it would be naive to expect elaborate arrangements for all watersheds.

Nevertheless, the concept of integrated watershed planning should underlie a modern approach to water resource management, recognizing that its full application will be impracticable or unnecessary in many watersheds. Critical river systems warrant the most sophisticated arrangements. In some cases, several watersheds with similar features can be grouped for regional planning purposes. In other cases, crude plans will suffice. The objective should be to ensure that management plans for any watershed are sufficiently developed to enable necessary management decisions to be made in light of all their significant effects on other uses and values. We therefore recommend:

10.1 The federal government should adopt integrated watershed management as a principle of federal water policy.

The federal government should adopt this principle in managing watersheds under its jurisdiction, and should require provincial governments to adopt it as a condition for its participation and support in studies, plans and programs undertaken jointly with them.

Implementing cooperative management calls for flexibility in meeting different circumstances. One important consideration is the nature and role of the organizational body, which can vary from an informal consultative committee to a board with management responsibilities. Some of the most successful experiments, such as the river authorities in England, Australia and Ontario, involve management boards with regulatory powers, and sometimes independent sources of revenue. (2) But this requires the government to delegate considerable responsibility, which in many cases would be difficult.

The composition of such bodies must also be considered, in particular, how major private interests or the public at large will be represented. This must be decided in light of local conditions and political circumstances. The federal government should participate directly when significant federal support is involved, when the watershed is interjurisdictional, and when federal responsibilities such as fisheries and navigation are particularly important considerations in management planning.

Arrangements for public participation should also be adopted to suit individual circumstances. In some cases, occasional, informal public consultations will suffice; in others, formal arrangements, involving advisory bodies and continuing opportunities for public review, will be appropriate.

Demand Management

Water management in Canada has traditionally focused on managing supplies. Natural water systems have been harnessed, stored, regulated and diverted in various ways to accommodate needs as they arose. Typically, the most convenient sources were developed first; then as needs expanded, the less accessible, more costly resources were developed. As long as water was plentiful relative to demands, supply management was a logical and satisfactory approach.

Today, however, the policy of simply increasing supplies to meet growing demands is being questioned. First, the cost of providing additional supplies for municipal, industrial and agricultural uses typically rises sharply when the infrastructure must be expanded and delivery systems extended to tap more remote sources. Second, increasing supplies, with the diversions, storage and other works that this typically involves, inevitably disrupts natural water systems.

To reduce the need for expanding supplies, opportunities are being explored for managing demand. These involve using water more efficiently by improving technology, and by introducing measures to conserve water and incentives to avoid waste.

Our response to the oil crisis of the mid

1970s is instructive in this context. Then, in the face of sharply increased energy costs, efforts were made throughout the economy to conserve energy. The effects on industrial processes, housing design, automobiles, and the public's sensitivity to ways of conserving energy have been profound. As a result, the growth in demand for energy supplies has been dampened considerably. While the rationale for conserving water is different, the opportunities for controlling our demands are comparable.

We were impressed by how many of those who made representations to this inquiry were aware of the opportunities in demand management. Suggestions ranged from the design of water-efficient plumbing in residential housing to recycling systems for industrial plants, improved irrigation methods and pricing methods for water supplies. Interest has undoubtedly been sharpened by recent water conservation policies in the United States and elsewhere, and by concerns about pollution and environmental disturbance in Canada. This new readiness to consider policies for conserving water represents a fundamental change from traditional supply-oriented attitudes toward water management.

Substantial opportunities exist for improving the efficiency of water use. More than 1500 cubic meters of water per capita per year are withdrawn in Canada. This exceeds the withdrawals of all other countries except the United States, and is more than double the amount of water used in some western European countries. In central and eastern Canada, the scope for higher efficiency is especially broad in the municipal, industrial, and thermal power sectors. In western Canada, the opportunities are greatest in agriculture, followed by thermal power and industrial uses.

By adopting demand management techniques, we can undoubtedly reduce costs and avoid environmental disruption. We have therefore concluded that water management in Canada should shift from its traditional reliance on supply management to a more balanced policy involving more attention to demand management.

Pricing. An obvious way to discourage waste and to provide incentives to use water efficiently is to charge a price for it. This has been shown to be an effective way to control demands for water in Canada and elsewhere (3), and thus supports the testimony of many informed commentators at our public hearings who advocated water pricing. The Consumer's Association of Canada (4), the Canadian Federation of Agriculture (5), the Department of Natural Resources of Manitoba (6) and the Canadian Labour Congress (7) all recognized the beneficial effects of pricing. Many other knowledgeable organizations and individuals also advocated pricing policies. We should point out that the federal government has already endorsed the "user pay" principle in its 1978 statement on water policy and in an international statement on this matter issued by the Organization for Economic Cooperation and Development. (8)

At present, pricing arrangements for water in Canada are rudimentary. Many municipalities levy fees for water and sewage services, but often only at fixed rates and rarely with reference to all costs. Most provinces charge fees for water used for electrical power generation, and modest rates are sometimes levied for water used for irrigation and other industrial purposes. British Columbia has adopted the most advanced pricing policy, but it is still in the process of being implemented.

Rationale for pricing water. When water is provided without a price attached to it, users cannot be expected to recognize the value of the resource or the costs of supplying it and disposing of it safely after it is used. Water is regarded as a free good, and users, lacking any financial incentive to economize, tend to use it wastefully. Excessive use creates a need for additional supplies, which leads to higher costs and added pressures on resources. Citizens bear both the financial and environmental costs in one way or another, though the burden is not distributed among them according to the resources they use. These considerations underlie the increasing support for pricing water. A suitable price can serve several useful purposes:

- It will create incentives to avoid waste and to use water efficiently, thus contributing to water conservation.
- By reducing the water needed and the waste disposal capacity, it will reduce infrastructure costs.
- The resulting lower demand will reduce environmental pressures on water resources.
- By demonstrating users' willingness to pay for water, prices help allocate sup-

plies among the uses and users so that the highest value is generated from limited resources.

- Pricing will generate revenue to cover the cost of water supply and waste disposal systems.
- Suitable pricing can ensure that the cost of water services is equitably borne by the beneficiaries according to the benefits they receive.

These advantages have convinced us that the pricing of water supplies should be a fundamental part of federal water policy. We therefore recommend:

10.2 The federal government should encourage water conservation and demand management practices by explicitly endorsing the principle that beneficiaries should pay for water and wastewater services by means of appropriate prices.

We propose in Chapter 13 that this principle be implemented for water under federal jurisdiction. Later we suggest that the federal government require an appropriate pricing system as a condition of federal participation in water development projects under agreements with provincial governments. By so doing, provinces and municipal water utilities will be encouraged to enact practical water pricing schedules for all water uses and to fund water supply services from fees rather than from general taxation.

The federal government, also, should explore opportunities for shifting the funding of its water programs from general taxation to revenues derived more directly from beneficiaries. In later chapters we propose charges for the use of water under federal jurisdiction, and fees for data and other information provided on special request. Other possibilities include taxes on water-using products, fees for services and for the use of facilities such as canals, and levies linked to the user charges of other governments and agencies.

Pricing systems. An ideal pricing system for water would require users to pay a price for the water they use at least equal to the costs of providing it. This usually implies two elements in a rate schedule. One is a price per cubic metre (1000 litres) of water used, or a commodity charge. Such a price should be set at a level equal to the incremental (or marginal) cost of providing the water; that is, the long-term marginal cost of additional supplies. This will ensure that users recognize the cost they impose on the system when they use water.

The second element is a fixed charge. Because the marginal cost is often lower than the average cost (because of economies of scale in water systems), a fixed rate per year or per month can appropriately be levied to cover the difference between the total costs of the system and the revenue collected from commodity charges.(3) The same principles can be applied to sewage and wastewater systems.

If the pricing system is to fully serve the purposes we have noted above, it must account for all the costs involved. This includes both operating costs and capital costs including depreciation. It should also recognize the value of the water itself, including its opportunity cost wherever limited supplies are demanded for other useful purposes. And, where appropriate, it should embody an allowance for environmental damage associated with the water supply or wastewater disposal. Charges for wastewater should, ideally, take account of both the quantity of effluent discharged into the system and the concentration of pollutants it contains.

Designing and implementing a water pricing system of this kind faces many complications. First, the water used by each user must be measured. Installing meters involves a cost (currently, about $170 for a residential consumer), which in some cases may exceed the benefits derived from pricing. Second, municipal water supply systems normally add at least a third to the capacity required by consumers to provide for fire protection, and surplus capacity is usually built into new waterworks and sewage systems to accommodate future growth (referred to as a "readiness to serve" allowance). The cost of such excess capacity is often considered to be an appropriate charge against ratable property rather than being added to the price paid for water used.

Third, since both the available water supply and the demand for it vary seasonally, a sophisticated pricing system would provide for higher commodity charges during periods of heaviest demand on the system, normally in summer.

Fourth, appropriate prices for wastewater disposal are complicated by the variation in the amount of effluent a user discharges, the

contaminants it contains, and the treatment it requires. A monitoring and pricing system that allows for all these variations would be exceedingly complex. In practice, simpler formulae can be adopted, such as classifying users according to the type of effluent they discharge (e.g. households) and charging them uniformly; and, for users whose discharges are highly correlated with their withdrawals, a wastewater surcharge could simply be added water supplies charges. We consider ways to identify appropriate charges later in this chapter.

Other conservation measures. In addition to restraining demand by pricing, opportunities to use water more efficiently are almost limitless. Water and wastewater utilities can control leaks by installing pressure controls; extraneous flows into sewerage systems can be controlled; effluents can be reclaimed for irrigation and cooling purposes; plumbing by-laws can be designed to require water-conserving equipment in new installations, and old plumbing can be retrofitted with conserving devices. (9)

Industrial and thermal power users also have opportunities to reduce demands on water and wastewater systems. Recycling techniques, already widely adopted in response to wastewater treatment requirements, can be expanded and improved; cooling towers and ponds can replace once-through systems (increasing consumptive losses but substantially reducing withdrawals); air-cooling systems can eliminate the need for water altogether; wastewater can be reclaimed for cooling and other purposes; water-efficient devices and processes can be used; and water-saving strategies can be adopted involving water audits, awareness programs and research on uses for reclaimed water.

Agricultural users could also substantially reduce their demand for water. New agricultural techniques have been developed to increase crop production without irrigation; soil moisture can be conserved by reducing summer fallowing, managing snow, planting drought-resistant crops, and carefully timing agricultural operations; losses from irrigation systems can be reduced by lining and improving canal design, installing pipe systems, using more efficient water application equipment and scheduling irrigation demands. Many of these irrigation improvements have demonstrated impressive results in Israel, United States and western Canada.

Household demands offer numerous opportunities for conservation as well. Low flush-rate toilets can reduce the per capita water use by as much as 30 litres per day; low-flow shower heads and improved laundry washers can also significantly reduce daily per capita use; regulated garden watering can substantially reduce demands during the peak summer season.

Finally, water conservation can be promoted through improved public awareness and education.

Later, we propose specific measures to take advantage of some of these opportunities for water conservation.

Supply Management

Canada has had considerable experience in developing water supplies to meet industrial, agricultural, municipal, navigational and other needs. It has built dams, storage reservoirs, and other structures to augment and regulate natural flows; and it has built canals and pipelines to transport water to where it is needed. Some of these projects have been huge, among the largest in the world, but the small waterworks are more numerous.

Measures to conserve water and to restrain growth in demand, of the kind discussed above, will reduce the rate at which supplies must be expanded. Nevertheless, developing water supplies will continue to be an important part of water management in Canada.

Much effort in the past has been directed to water storage. Typically, dams have been built to store river flows during periods of high runoff so they can be released when needed. The Gardiner Dam that created Lake Diefenbaker in Saskatchewan, the Columbia River dams in British Columbia, and some of those that comprise the James Bay project in Quebec, among many others, were designed in part to regulate flows. In some cases, flows have been augmented by transfers from other watersheds.

Reservoirs and flow-regulation works can serve many purposes. They can supply water to hydroelectric plants, ensure irrigation supplies during dry summer months, prevent flooding downstream, provide recreation and improve navigation.

But they are being increasingly constrained by two factors. One is cost. In regions where water is scarce and demands

are strong, the best opportunities to store water and augment low flows have already been exploited. In settled regions, the most attractive hydroelectric sites have been developed. So, although many possibilities remain, new projects will be increasingly expensive. The other constraint is a growing concern about the environmental disruption and social dislocation that these projects often cause.

Project evaluation. Many past projects have been criticized for their failure to take into account all their impacts. While they serve the particular purpose they were built for, they often adversely affect inhabitants of the area who depend on natural water systems, the fish and wildlife the waters support, and other uses of the water.

For these reasons, large water projects have encountered increasing resistance in recent years. New interest has been shown in small-scale alternative water supply systems, such as on-farm containment and storage, wells to tap groundwater for domestic supplies, dugouts for livestock watering and small rural supply networks.

Nevertheless, substantial new water projects are being contructed in Canada and more are being planned and investigated. We believe federal participation in such projects should be based on more rigorous and consistent criteria than in the past. Proposals should be thoroughly evaluated to ensure that all the costs and benefits are systematically assessed, that they are undertaken only when the benefits exceed the costs, and that all feasible alternatives and modifications are considered. We therefore recommend that:

10.3 Comprehensive and consistent criteria should be adopted for evaluating water development projects in which the federal government participates. Evaluation procedures should:

- **i) take unbiased account of all direct and indirect costs and benefits, including social, environmental and regional development impacts;**
- **ii) systematically assess all risks and uncertainties, and the implications of irreversible decisions;**
- **iii) consider all practicable alternatives and design modifications;**
- **iv) weigh the benefits against the costs according to consistent federal criteria;**
- **v) monitor the impacts of all major projects after their completion.**

These comprehensive evaluation procedures complement our recommendations for integrated watershed management.

Consistent evaluation methods are essential if limited public funds are to be spent in the most beneficial way. The methodology for project evaluation is now well developed, and significant advances have recently been made in techniques for assessing risk and uncertainty. (10) Furthermore, the federal Treasury Board has already established standard procedures for assessing projects (11), which could be adapted to water-related projects. In particular, their Benefit-Cost Analysis Guidelines should be interpreted for such projects. The Interdepartmental Committee on Water, with the support of Treasury Board, should undertake this task.

Interbasin transfers. Some water development projects, typically large-scale ones, involve augmenting water supplies by diverting flows from neighboring basins. We have noted in Chapter 3 the impressive number and scale of interbasin transfer projects in Canada.

Interbasin transfer projects have many of the same effects as other water projects, but they also raise special problems that warrant careful attention. Because they involve augmenting flows in one watershed at the expense of another, the hydrological regime in both is altered with possibly substantial and irreversible environmental change. Furthermore, by connecting two separate water systems, parasites and other organisms can be introduced to new environments where they can have significant and unpredictable effects. These effects are likely to be particularly serious where transfers are made from one oceanic basin to another and where estuarial conditions are sensitive. Such alterations in river discharges can upset the balance of natural marine processes and may have profound effects on fisheries and on the productivity of coastal waters generally. (12) A significant characteristic of all these effects is that they are poorly understood.

Moreover, the economic base and the lifestyle of many rural and northern communities are adapted to the seasonal fluctuations of natural water regimes for fishing, hunting, tourism and transportation. (13) They may therefore be seriously affected by major diversions. Because of these problems, we specifically recommend:

10.4 Projects involving transfers of water from one basin to another should be considered only with great caution and only when alternative means of serving the purpose are infeasible. Federal involvement in such projects should be based on comprehensive evaluation of proposals including careful analysis of economic, social and environmental impacts in both donor and receptor basins.

New projects involving interbasin transfers may nevertheless be justified in some circumstances. We are particularly concerned about the possible future need to augment natural flows into the Great Lakes to maintain levels in the face of growing consumptive demands and long-term climatic change. This may necessitate diverting at least small quantities of water into the Lakes from other basins. The International Joint Commission, in its recent report on Great Lakes Diversions and Consumptive Uses has recommended that a bilateral task force review this matter. (14) We support this recommendation.

Program Development

The foregoing general approaches should guide the development of specific federal programs, to which we now turn.

Municipal Programs

Municipal water systems account for only about 11 percent of water withdrawals in Canada, but they serve more than 21 million Canadians. (15) According to surveys, about 84 percent of the municipal population is served by sewers but only 57 percent by some form of sewage treatment.

Water supply and wastewater systems represent tremendous investments. Total replacement cost of Canadian waterworks and wastewater systems are estimated at $62 billion and $47.5 billion, respectively. This amounts to $3 thousand per capita served for each system. (16)

During this inquiry, we were struck by the enormous task of providing and maintaining adequate municipal water, wastewater and drainage systems in Canada. Some communities need to protect their water supplies from contamination. Others need to improve wastewater treatment facilities. Some need to reconstruct and separate combined sewage and urban drainage systems to reduce pollution of receiving waters. Many need to rehabilitate aging water supply and wastewater treatment systems. (17)

In 1984, an estimated $2.4 billion in capital costs alone, was spent on providing new or upgraded services, but this is clearly insufficient to provide and maintain the facilities needed. (18) But the ability of local governments to adequately respond to current needs has been impeded by recent high interest rates and economic recession that has forced spending restraints.

Two avenues are available to address these problems, and the federal government can play an important role in both of them.

Assistance programs. In recent decades the federal government has embarked on several assistance programs for improving municipal infrastructure.

A highly successful program was the Municipal Infrastructure Program of the Central Mortgage and Housing Corporation. At the beginning the program consisted only of loans, a portion of which was forgiveable under certain conditions for sewage collection and treatment. In 1975, the program was revised and extended to improving and expanding municipal water supply systems. The Municipal Infrastructure Program ran for eighteen years, until it was terminated in 1978. It provided cooperative assistance and encouraged municipalities to abate pollution and provide comprehensive services.

Almost 1,500 municipalities containing about 75 percent of Canada's population took advantage of the program. Their populations ranged from two hundred to two million. The assistance loans varied from $3 thousand to over $10 million, and complementary or supplementary assistance was made available by several provinces following 1961 amendments to the *National Housing Act*. Almost $2 billion were committed in loans and $690 million in grants.

While the Municipal Infrastructure Program was in place, several other programs

were also available for related purposes. Each was intended to respond to a specific need (such as regional development or agricultural employment in the Atlantic region) and each had its own eligibility criteria and financing arrangements. Similar programs are available today. For example, subsidiary agreements under Economic and Regional Development Agreements fund water infrastructure for specific purposes such as agriculture or industrial development. These arrangements and others, described in Chapter 9, lack consistent terms and conditions, and they are available only in certain provinces and only to a few municipalities. Therefore, they cannot meet the general need for rehabilitating water infrastructure in Canada.

Though we believe beneficiaries should pay for the cost of water and wastewater services, and though provincial governments are responsible for municipalities and their water supplies, the magnitude and cost of needed improvements and the federal interest in health and environmental quality have led us to conclude that the federal government has a role to play in this matter. The federal government should provide at least a temporary catalyst for coping with this widespread and urgent problem in Canada. We therefore recommend:

10.5 The federal government should consult with provincial governments and their municipal water utilities to determine the most appropriate means of improving and financing construction and improvement of municipal water, wastewater and stormwater infrastructure.

The primary objective should be to improve water and wastewater systems in Canada in the interests of public health and environmental protection. However, subject to the provincial agreement, any program should include related activities as well.

For example, strengthened training programs and a national standard of certification are needed for operators of water and sewage treatment works. Water and wastewater facilities are now frequently improperly operated and maintained, and training is inadequate. The Department of National Health and Welfare and Environment Canada, in collaboration with many provinces, the territories and professional organizations such as the Federation of Associations for the Canadian Environment and the Water Pollution Control Federation have sponsored operator training programs. Certain provinces have established operator training and certification programs as well.

When an adequate supply of trained operators becomes available from current training programs, provinces should be encouraged to make the certification of waterworks and wastewater treatment operators mandatory. A national certification standard would ensure that provincial certification standards are consistent.

A need also exists for a program of testing, rating and certifying equipment, materials and chemicals used in water and wastewater systems, perhaps under the aegis of the Canadian Standards Association. A few years ago, Health and Welfare Canada cancelled a program of this kind because of insufficient funds. This provoked complaints from manufacturers as well as municipal and provincial governments. It also disadvantaged Canadian manufacturers because their American competitors promote their products on the strength of United States certifications, for which there is no Canadian counterpart.

Pricing municipal water and wastewater services. The capital and operating costs of water supply and wastewater systems are generally covered by an amalgam of intergovernmental grants, tax revenues, fixed levies and fees based on recorded use. In 1981, government grants provided slightly more than half of the capital cost of new municipal water systems, up sharply from 27 percent in 1975, due mostly to a new program in Quebec. Charges levied on users covered 75 percent of recorded costs, but because recorded costs normally exclude grants and amortization allowances, the proportion of true economic costs covered by user charges is much lower. (3)

Only half of the municipal supply systems in Canada, typically the larger systems, meter the water used by their customers. The most common pricing formulae use declining block rates: the greater the quantity used, the lower the rate. Two-thirds of the systems combine declining block rates with a minimum charge regardless of the amount used.

The cost of sewage works is often recognized by a surcharge on water billings, which creates inequities among consumers when they vary in the extent to which they

return withdrawals, pollute the water they use, or augment municipal water with supplies from other sources. Some utilities apply an industrial waste surcharge, which involves an extra levy on wastes that exceed specified volumes and concentrations. Most municipalities simply limit the volume and strength of sewage discharged into their sewage systems.

Our investigations have revealed a variety of deficiencies in the pricing systems of municipal water utilities in Canada. Of these, the most general are the following:

- Many users are unmetered, and so are not assessed according to their demands on the system.
- Some costs, including depreciation, are not accounted for.
- Charges do not cover full costs.
- The value of the water itself (apart from the costs of delivering it) is not recognized.
- The allocation of costs among fixed rates, minimum user fees and per-unit prices is unsystematic.
- Declining block rates blunt incentives to conserve water and leave users paying varying marginal rates.

Despite pricing's ability to encourage more efficient use of existing supplies, efforts to implement modern pricing systems have been limited. This is probably due in part to senior government subsidies, which have reduced incentives to recover full costs. Other deterrents may be concerns about redistributing the burden of costs from taxpayers to beneficiaries, and about the effect on the development of communities with high cost supplies.

Notwithstanding these concerns, the advantages of pricing are substantial, and we consider suitable pricing policies a prerequisite for effective water management in Canada.

In the United States, a landmark report in 1951 established the principle of charging beneficiaries for the full costs, approximately in proportion to their demands on the facilities. (19) As this inquiry was being completed, a new American report testified to the growing acceptance of this principle. (20)

Given some of the difficulties in determining appropriate rate schedules and constraints in implementing pricing at the local level, and the meagre attention that water pricing has received in Canada, we have concluded that a thorough economic analysis is required. We therefore recommend:

10.6 The federal government should have the Economic Council of Canada undertake a thorough study of appropriate pricing for municipal water and wastewater services in Canada. This study should:

- **i) be undertaken in consultation with provincial governments and water utilities;**
- **ii) take account of experience with water pricing systems in other countries;**
- **iii) estimate the economic benefits of appropriate pricing, taking account of its social impacts and implications for regional development;**
- **iv) make recommendations for implementing suitable pricing systems in Canada including the practicability of universal metering.**

This recommendation implies a reference to the Economic Council of Canada under section 10 of the *Economic Council of Canada Act*. The council is well placed to undertake this study because of its expertise in utility pricing (illustrated by its recent study of electricity pricing) and its working arrangements with provincial governments. This study should examine the practical techniques of water pricing in Canada and, by providing public information on the benefits of pricing, assist with policy development in all jurisdictions.

Agricultural Programs

As we indicate in Chapter 9, the federal government has been heavily involved in irrigation projects, drought proofing and drainage programs related to agricultural development, usually in cooperation with provincial agencies. And as we noted in Chapter 4, irrigation consumes more water in Canada than any other water use.

Our research and the evidence presented at our public hearings suggest several deficiencies in the government's approach to these programs. (21)(22) One of these is the lack of vigorous and consistent evaluation procedures. In the absence of such assessments, it cannot be determined whether they are in the public interest or whether the

most advantageous projects are accorded priority. Indeed, the evidence suggests that many projects involve costs that exceed the benefits generated. (23)

A related criticism is the failure to consider the full environmental impacts of irrigation and drainage projects. Some of these effects are borne by the agriculture sector itself, such as soil erosion and salinization. Other effects are less direct, but can be significant nevertheless. Drainage works can alter hydrological regimes sufficiently to affect river flows and sometimes contribute to flooding downstream; irrigation can aggravate waterway pollution with insecticides and herbicides; draining wetlands can result in the loss of valuable waterfowl and wildlife habitat. These impacts imply a need to assess such projects more comprehensively and in the context of the watershed as a whole.

As we already noted in Chapter 7, some agricultural water development programs are designed only for certain parts of Canada, which conflicts with our principle that federal programs should be accessible to all Canadians. In addition, the payments made by the beneficiaries of these programs fall substantially short of the costs, which is inconsistent with our earlier recommendations on this matter. To correct these deficiencies, we recommend:

10.7 The federal government should participate in irrigation and drainage programs only under cost-sharing agreements that are available to all provinces on a consistent basis. To qualify for federal support, projects should:

- **i) be in the form of off-farm, collective or community works;**
- **ii) be subjected to comprehensive evaluation to determine all their effects in the watershed and to demonstrate that their benefits exceed costs according to benefit-cost analyses appropriate for water-related projects;**
- **iii) provide for charges to the direct beneficiaries that reflect the cost of providing them with the benefits they receive.**

At present, charges for irrigation water supplied by federally assisted projects are about $14 per hectare in Alberta and Saskatchewan, while the cost of delivering new supplies to the farm gate is about five times this amount. Charges also fall short of the value of the irrigation water in terms of the enhanced value of crops produced, which ranges up to an estimated $40 per hectare per year depending upon crops produced and local conditions. (22) The difference between this value and the price paid for water tends to become capitalized in higher values of irrigated land and higher rental rates. Similarly, the costs of drainage projects are only partially born by the beneficiaries.

In many cases, farmers likely could not afford to pay the full cost of new irrigation supplies, which itself suggests that the benefits may not exceed the costs. Early projects, exploiting the most accessible water supplies, may well have been economically advantageous, while new projects may not be.

Apparently, the direct beneficiaries have been charged only a fraction of the cost of irrigation and drainage projects on the grounds that benefits accrue to people other than the landowners through increased business activity and employment beyond the farm. But this argument does not support pricing at less than the value of enhanced farm production. Moreover, the off-farm, secondary benefits of these works must be evaluated cautiously because similar impacts result from almost any type of public spending. In any event, the distribution of the benefits generated by projects of this kind should be analyzed to ensure public funds are spent efficiently.

Flood Control Programs

In Chapter 9, we described the federal government's national flood damage reduction program. This program supplements structural measures — still required in some areas to protect existing development — with measures to prevent escalating losses in the future from new developments in vulnerable floodplain areas.

The response to this program has generally been favorable, though some provinces are clearly more interested in federal funds for structural protection of existing developments in designated areas, and some communities are concerned about the adverse impact on land values when flood risk is publicized.

Federal funding under this program has levelled off, although most of the original agreements have been extended for several more years and subagreements are still being negotiated for mapping, flow forecasting, other studies and structural protection.

We believe that the federal government should undertake the following activities in support of flood damage control:

- compile hydrological data and other information relevant to the threat of flooding in cooperation with provincial and territorial governments;
- support emergency measures and flood disaster relief in cooperation with provincial and territorial governments;
- Provide flood control works where direct federal interests such as navigation facilities and Indian lands are threatened or where the extent of losses are of national significance. This should be done in cooperation with other governments where other interests are threatened as well.

The federal government is already involved in all of these activities, at least in some parts of Canada. Transport Canada undertakes in the lower St. Lawrence River ice-breaking for navigation and flood control. Disaster relief is also suitably organized; its cost is shared with the provinces and it covers disasters other than floods as well. But, federal participation in dykes and other flood control works is too broad. We therefore recommend:

10.8 Federal activities related to floods should be confined to:

i) compiling hydrological data about flooding and flood risk;
ii) constructing flood control works where federal interests are threatened or where damages are likely to be of national significance;
iii) providing emergency and disaster relief.

Any flood control works involving federal support should be covered by federal-provincial cost-sharing agreements and, where appropriate, designed in the context of watershed management plans. They should also be subjected to rigorous evaluation, as we have already suggested.

Industrial Programs

Current regulations. At present, to enforce the pollution control provisions of the *Fisheries Act*, the federal government has adopted uniform effluent standards. These, however, are inadequate to consistently protect fish habitat in widely differing conditions. Small streams cannot safely absorb as much waste as big rivers. Where many dischargers border a river, the water quality can be maintained only if they meet more stringent standards than where there are few, and so on.

Nor can such regulations respond sufficiently to the requirements of integrated resource management. A stream that supports valuable fisheries warrants a higher standard than one that does not. Other demands on water and public objectives differ in different watersheds, and so on. What is needed is a procedure that takes into account the circumstances and needs of each situation in a comprehensive resource management framework. We therefore recommend:

10.9 Administration of the deleterious substances section (Sec. 33(2)) of the *Fisheries Act* should be based not only on national baseline standards for industrial effluents, but also, and more importantly, on site-specific controls consistent with the integrated resource management requirements of particular watersheds.

We thus advocate site-specific management, based on the environmental conditions and pressures in each circumstance, instead of relying entirely on uniform discharge standards set out in regulations. This would undoubtedly improve fish habitat protection, but it would also require more managerial resources and information. The changes should therefore be made gradually with priority given to the most sensitive watercourses, to watercourses subject to the heaviest demands, and to watercourses subject to provisions for integrated watershed management. In this way, the uniform industry effluent standards can be expected to be superceded, over time, by the more discriminating site-specific approvals.

These recommended site-specific approvals are consistent with those we proposed in Chapter 7 for authorizing new developments under the *Fisheries Act*, and should be integrated with them where an undertaking requires both.

Compliance. Industrial pollution remains the greatest single threat to water

quality in Canada, but, as we observed in Chapter 5, some significant progress has been made. For example, since the federal government introduced new regulations governing liquid effluents in 1971, our largest industry, the pulp and paper industry, has increased production by 20 percent (from 54,000 to about 65,000 tonnes per day) while reducing the suspended solids discharged in pulp and paper effluents by two-thirds (from 2,648 to about 970 tonnes per day). Nevertheless, this still exceeds the compliance level of 655 tonnes per day for the 123 mills in Canada. (24)

Efforts to reduce the amount of oxygen-demanding materials discharged have also yet to achieve compliance levels. Despite expenditures of several billion dollars, including substantial governmental assistance, the pulp and paper industry continues to discharge oxygen-demanding wastes that equal in strength all municipal sewage in Canada even before it is treated. And many mills still do not have specific schedules for complying with the regulations.

Currently, two types of tax concession apply to pollution control equipment. One exempts control equipment from sales tax. The other permits a company to write off the total cost of a pollution control device or process over three years, under an accelerated capital cost allowance. These incentives do not apply to water conserving equipment, however, although this would encourage more efficient water use and thereby reduce wastewater discharges.

Considerable scope remains for reducing industrial pollution through such measures as wastewater treatment, process change, recycling, reclamation and recovery. A renewed effort should be made to bring about the needed improvements, and so we recommend:

10.10 The federal government, in consultation with provincial governments and industrial representatives should accelerate efforts to reduce industrial pollution by:

- **i) reviewing and upgrading schedules for compliance with industrial effluent regulations;**
- **ii) extending the accelerated capital cost allowance for pollution control equipment to water conserving equipment;**
- **iii) investigating other means of providing incentives and assistance for improving the control of industrial effluents;**
- **iv) encouraging the development of corporate water conservation plans and quality control audits by providing information and other assistance.**

Corporate water management plans, developed and administered by joint management-labour committees, can embody strategies that link water conservation and pollution control to corporate objectives. Periodic water audits can identify opportunities for improvement. Employee awareness programs should be important elements of these plans.

A growing number of examples demonstrate that economic and environmental goals can be mutually reinforcing. Cooperative programs involving industry, labor and government have been remarkably successful in controlling air emissions and wastewater discharges from industrial plants. Process modernization in the pulp and paper industry has simultaneously enhanced productivity and international competitiveness while significantly reducing environmental stress. (25) Recycling and recovery in the chemical industry have dramatically reduced waste discharges, sometimes profitably and leading to new products. Energy conservation measures have achieved cost savings, conserved scarce hydrocarbons and reduced acid gas emissions from thermal power and transportation equipment. Imaginative recycling strategies in consumer products packaging as in milk jugs and aluminum beer cans have produced both environmental and economic benefits.

Drinking Water Guidelines

At our public hearings, we received many submissions about the safety of drinking water from environmental groups, regional authorities, provincial and federal departments, professional organizations and individuals. Their concerns centre on the increasing number of potentially toxic substances being detected in water supplies, the hazards they present and the level of risk to human health we should accept.

The federal government responded to these concerns in the 1978 Canadian Drink-

ing Water Quality Guidelines. But these guidelines are widely criticized as being incomplete, out of date, and insufficiently stringent. They are currently being revised and expanded by a federal-provincial working group that reports to the committee of Deputy Ministers of Health through the Advisory Committee on Environmental and Occupational Health. But the process seems extremely slow.

Adherence to the guidelines is voluntary. At present, only Quebec has enforceable legislation to ensure the quality of drinking water.

Many commentators feel strongly that all Canadians have a right to safe drinking water, which leads some to advocate strict federal legislation that would ensure "zero risk" in drinking water supplies throughout Canada. (26) However, several obstacles exist to guaranteeing consistently high standards for drinking water quality in Canada. (27) First, the federal government's authority to legislate in this field is constrained, as we explained in Chapter 6. Second, to establish exacting requirements for human health and to continuously revise them as new toxic substances appear requires a good deal of scientific information and administrative time and effort. Third, a heavy cost would be imposed on provincial and municipal governments if they were forced to improve supply systems to meet uniform, high standards. Fourth, ensuring compliance throughout Canada would put heavy demands on monitoring and enforcement mechanisms. Finally, in practical terms, risk to human health has no clearly definable limits; ultimately, it is a matter of degree.

Nevertheless, we have concluded that the widespread demand for at least minimum standards for drinking water quality in Canada is justified, and that the federal government should take the initiative in responding to this need. Given the limits to federal legislative power, the most satisfactory and practicable solution would involve setting minimum water quality standards agreed to by all jurisdictions with a commitment by each government to enact standards within its jurisdiction at least as stringent as the national minimum. This arrangement would leave each government responsible for legislating and enforcing standards suitable for its jurisdiction. To advance this approach we recommend:

10.11 The federal government should take the initiative in establishing minimum quality standards for drinking water throughout Canada by:

- **i) seeking the cooperation of the provinces in revising and expanding the existing national drinking water guidelines as a matter of urgency;**
- **ii) inviting the provinces to participate in designing a model safe drinking water act suitable for adaptation and adoption by each jurisdiction;**
- **iii) passing a safe drinking water act to apply to waters under federal jurisdiction.**

The federal government should apply its own safe drinking water act in all areas of federal responsibility including Indian reserves, military bases, federal airports, as well as the northern territories.

The scope of provincial constitutional authority in this matter makes us hesitate to propose that the federal government attempt to legislate standards of drinking water quality for all Canada. However, if the approach we recommend here fails to result in enforceable minimum standards throughout Canada within a reasonable time, the federal government should consider taking more direct action.

Other Water Quality Guidelines and Objectives

As we noted in the preceding chapter, the federal and provincial governments have been attempting to establish guidelines for other water uses such as for agriculture, recreation, fish and wildlife. The Canadian Council of Resource and Environment Ministers established a task force in 1983 with a mandate to inventory and assess the water quality criteria and guidelines presently used by governments in Canada, to recommend possible ways to harmonize the guidelines, and to identify emerging issues in water quality. In its 1984 report, the task force concluded that it should be authorized to prepare draft guidelines for the Canadian Council of Resource and Environment Ministers. (28)

Quality guidelines for major water uses are almost essential for establishing site

specific objectives for particular bodies of water. All agencies involved in watershed management planning could benefit from this kind of guidance. The federal government should use its influence, through the Canadian Council of Resource and Environment Ministers, to encourage the provinces to collaborate in designing these needed water quality guidelines. We therefore recommend:

10.12 The federal government should increase its efforts to reach agreement with the provinces on water quality guidelines for major water uses.

Toxic and persistent contaminants

The most urgent need in water quality management policy in Canada is a comprehensive program for controlling toxic substances. Judging from the submissions at our public hearings and other evidence available to us, the proliferation of new toxic and persistent substances that find their way into waterways is the single most widespread concern about water management. Today Canadians are demanding more effective control of these pollutants, and we believe their concerns are well justified.

The federal *Pest Control Products Act*, *Food and Drug Act*, *Environmental Contaminants Act*, *Clean Air Act* and *Transportation of Dangerous Goods Act*, as well as a variety of provincial statutes all provide some control over chemicals and other contaminants. And as this report was being written, new and controversial regulations governing the transportation of dangerous goods were introduced. But none of these, nor all of them together, provides a sufficiently comprehensive means of coping with this problem.

An effective policy must establish control over toxic substances before they are used and ensure that control is maintained "from the cradle to the grave". The amendments we proposed in Chapter 7 to the *Environmental Contaminants Act* will contribute to this approach by defining toxic substances, requiring that they be approved and registered before being used, and then used only under strict regulations. But they will not, on their own, solve the control problem. The solution calls for responsibilities within the federal government itself to be clearly delegated and for intergovernmental coordination at the political level. We therefore recommend that:

10.13 To develop more effective controls over toxic substances and hazardous wastes, the federal government should:

- **i) designate the Minister of the Environment as the federal coordinator for toxics control;**
- **ii) seek stronger intergovernmental coordination of control programs through the Canadian Council of Resource and Environment Ministers;**
- **iii) promote a "cradle-to-grave" approach in controlling toxic substances;**
- **iv) support investigations of new control policies through expert consultations convened by the Minister of the Environment.**

Intergovernmental consultations should consider the need for new institutional arrangements for controlling toxic substances. For example, a toxics control commission, along the lines of the Atomic Energy Control Board, might be advantageous.

The whole question of controlling toxic chemicals is currently being studied by a special study group organized by the Niagara Institute, and by the federal government's Interdepartmental Committee on Toxic Chemicals, and by a committee of the Canadian Council of Resource and Environment Ministers. Recommendations from the first group are expected imminently, and will undoubtedly warrant careful consideration.

Atmospheric pollution

Another new and alarming environmental problem is atmospheric pollution, and acid rain in particular. As we noted in Chapter 5, acid rain has already affected many sensitive bodies of water in central and eastern Canada, and its effects are beginning to appear in some areas in western Canada as well. While acid rain is a major threat to water quality in Canada, it is a problem that extends well beyond water policy, and its dimensions are international.

Within the last few months, important steps have been taken toward controlling acid rain.

- Quebec has passed regulations to reduce the sulphur dioxide emissions of Canada's second largest single source, Noranda Inc., by 50 percent by 1989.
- The federal government has subtantially tightened Canadian standards for nitrogen oxide emissions from automobiles.
- The federal governments of Canada and the United States have appointed envoys to investigate and make recommendations about a coordinated effort to reduce airborne emissions.
- The premiers of the eastern provinces and the governors of the New England states pledged themselves to reduce sulphur dioxide emissions in their regions by 32 percent within the next nine years.
- The governments of Canada and the eastern provinces have reached a complementary agreement, with the necessary funds committed, to reduce sulphur dioxide emissions from Canadian sources by 50 percent by 1994.
- In July 1985, Canada, along with nineteen other countries, signed a protocol to reduce national emissions of sulphur dioxide by 30 percent by 1993. This protocol was pursuant to the 1979 signing of the Economic Commission for Europe Convention on Long Range Transport of Air Pollutants.
- To coordinate federal activities, an Interdepartmental Long Range Transport of Air Pollutants Committee reviews programs and coordinates related activities in all federal departments.

These new initiatives offer some hope that recent trends in atmospheric pollution will be reversed, but it will be important to maintain a vigorous and coordinated effort.

Accordingly, we recommend:

10.14 The federal government should vigorously pursue efforts to control acid rain by:

i) pressing forward its arrangements with provinces to achieve the targeted reduction in acid-causing emissions by Canadian industry;

ii) using all its available influence to induce the government of the United States to substantially reduce airborne pollutants that are transported into Canada;

iii) support multinational research on global atmospheric pollution and efforts to establish international cooperation in controlling it.

Conclusion

In this chapter, we have suggested that governments need to adopt a more balanced approach to water policy. First, more consideration should be given to the interdependent uses of water systems, which leads us to advocate an integrated approach to the management of watersheds. Second, to correct the traditional emphasis on developing water supplies, more attention needs to be paid to managing the demands for water. Third, to overcome problems that result from projects designed to serve a particular purpose, we propose that development proposals be subject to comprehensive evaluations that recognize all economic, social and environmental impacts.

Finally, priorities change. While the traditional problems of water management remain with us, the threat to water quality from new forms of contamination, from new sources and on an unprecedented scale, calls for innovative policy development.

Chapter Eleven

The Search for Knowledge

For Canada to benefit for more than a brief instant in time from her rich heritage of water, she must strive to match her knowledge of the impacts of her actions to her capacity to act.

MANITOBA ENVIRONMENTAL COUNCIL

Good management requires, among other things, good understanding of the resource and its uses. And good understanding, in turn, depends on good research and data.

As the problems of water quality and quantity become more complex and interrelated, so the contribution of research to water management becomes more crucial. In this chapter we examine the federal role in water research and data collection, and how these activities are organized.

Complicating this examination is the fact that while water does not respect artificial boundaries, problems are often tackled on a local basis. The legitimate responsibilities and interests of the various levels of government must be recognized and respected, but proper water management must admit to the global nature of the resource. Thus, in research it is as important to understand large scale hydrological processes as it is to look at localized cases of water pollution. We must also appreciate the links between large-scale processes and local actions.

Current Provisions for Water Research

Water resources research in Canada involves a wide variety of participants. The federal government, provincial governments, universities, corporations, consultants and others are all involved in funding or conducting research programs.

The federal government funds external water-related research and conducts its own research in several departments. Most important among these are Environment, Fisheries and Oceans, Agriculture, National Health and Welfare, Energy, Mines and Resources, Transport, and Indian Affairs and Northern Development. Altogether, these departments are expected to spend about $60 million on water research in 1985/86.

Environment Canada

Environment Canada supports most federal water research. The 1985/86 budget estimates for the department provide for $43 million and 420 person years for this purpose. The Inland Waters Directorate performs most of this research.

The directorate operates two major research institutes: the National Water Research Institute and the National Hydrology Research Institute. The National Water Research Institute is headquartered at the Canada Centre for Inland Waters in Burlington, though it also maintains smaller establishments in Winnipeg and Vancouver. This institute conducts water research into the chemical, physical, biological and environmental problems of water systems. While its interests lie mainly with water quality, the institute also supports a major program in hydraulics and another in geophysical fluid dynamics.

The National Hydrology Research Institute is presently based in Ottawa but with new headquarters under construction in Saskatoon. This institute conducts research primarily on water quantity, though it investigates problems of groundwater quality, snow and ice as well.

Other agencies within Environment Canada also conduct water-related research. The Environmental Protection Service operates the Wastewater Technology Centre based at the Canada Centre for Inland Waters. This centre is responsible for developing new wastewater treatment technologies and sludge disposal techniques for municipalities and industries.

The Atmospheric Environment Service concerns itself with the meteorological aspects of water research such as precipitation and evaporation. In addition, as a part of the recently approved Canadian Climate Program, the service is funding research

related to the implications of climatic change on water resources of the Great Lakes-St. Lawrence system.

The Canadian Wildlife Service monitors and identifies contaminant levels in wildlife, and in doing so monitors toxic substances in the aquatic ecosystem. The Lands Directorate maps land use, monitors and assesses land-use changes, such as wetland conversion, and studies terrestrial ecosystems. These activities contribute to research on acid rain, soil erosion and land-use conflicts.

Environment Canada also funds research undertaken by nongovernment scientists. The Water Resources Research Support Program of the Inland Waters Directorate is designed to stimulate innovative research in the natural and social sciences with emphasis on water management problems. The program also encourages communication between the directorate and nongovernmental research institutions.

Funds for this program have been reduced substantially over the past decade. In 1973/74, grants totalling $1.1 million supported forty-four research projects at twenty-four universities as well as interdisciplinary water resource research centres at six universities. Shortly thereafter the program was reduced to $250 thousand, distributed among fewer universities.

Fisheries and Oceans Canada

The 1985/86 budget estimates provide $9 million and 220 person years for investigations of freshwater fish habitats. At the Freshwater Institute in Winnipeg, research is conducted on fish habitat and limnology, emphasizing biological production and decomposition in lake systems. Fisheries and Oceans also operates the Great Lakes Biolimnology Laboratory in Burlington, which focuses on environmental toxicology, surveillance and ecosystem studies.

Energy, Mines and Resources Canada

Energy, Mines and Resources Canada supports research on abatement of acid rain emissions from combustion sources and on environmental impacts of oil and gas exploration and development: $4 million and 30 person years are provided for these activities in 1985/86.

Agriculture Canada

Agriculture Canada allocated $3 million and forty-five person years for research related to water in the 1985/86 budget estimates. It conducts research into the relationships between water and crop yields, water conservation, soil and water interactions, erosion control, agricultural practices for protecting water quality and irrigation.

Other Federal Agencies

Other federal agencies conduct or provide funding for water-related research in support of their particular mandates. Health and Welfare Canada's modest research in water-related problems concerns the human health aspects of drinking water and recreational water quality.

Transport Canada conducts research related to freshwater transportation and navigation, such as techniques for extending the shipping season in the Great Lakes-St. Lawrence waterway.

The Department of Indian Affairs and Northern Development's water research activities range from studying northern river basins to investigating water pollution associated with northern development projects.

The National Research Council is a Crown corporation that undertakes and supports industrial and scientific research. Its 1985/86 budget estimates provided $4.4 million for its environmental quality program, much of which was related to water research. This program has supported the production of 120 environmental criteria documents and research on pollutants. However this program was reduced substantially at the end of 1984.

Several of these departments, including Environment Canada, Regional Industrial Expansion and Supply and Services, sponsor research, development and demonstration programs applicable to pollution control.

Granting Councils

As well as conducting research internally, the federal government contracts research out to private organizations and universities through the Department of Supply and Services or through various departments' research support programs.

The federal granting councils are the main sources of support for university research. The Natural Sciences and Engineering Research Council of Canada is the main source of funds for water research, though the Medical Research Council and

the Social Sciences and Humanities Research Council sometimes support related research projects.

Provincial Governments

Provincial governments maintain relatively modest in-house research capabilities, but they sponsor substantial research on specific problems carried out by private organizations. Many of the provinces also fund research councils, such as the Research Councils of Alberta, Saskatchewan and British Columbia, which devote some of their research effort to water problems specific to their provinces.

Universities

Universities carry out a significant share of the water-related research in Canada under a variety of arrangements. Some universities have multidisciplinary or interdisciplinary research centres that focus on water research; the Westwater Research Centre at the University of British Columbia and INRS-Eau are examples. Others have multidisciplinary institutes or programs that address water as one of several resource management concerns; the Natural Resource Management Program at Simon Fraser University and the Institute of Environmental Studies at the University of Toronto are examples. Still others have group research programs that focus on a particular aspect of water; the Division of Hydrology at the University of Saskatchewan, the Water Conservation Program at the University of Waterloo and the Watershed Ecosystem program at Trent University are examples. Finally, small groups of university scientists sometimes form temporary research teams to undertake specific projects, or individual scientists carry out studies with the support of research grants or contracts. The latter category accounts for most of the manpower and funding.

University water researchers obtain nearly all of their research funds from outside their universities, usually from granting agencies, government line agencies or the private sector. Their research usually complements educational programs, including the education of future researchers. Therefore, their continuing involvement in water resources research is particularly important for maintaining a long-term capability in water-related research in Canada.

The Private Sector

Many industrial and manufacturing firms conduct in-house research relating to water conservation or water quality. Industrial associations also fund research. Consulting firms conduct research for government agencies and the private sector. The nature and extent of private research is difficult to assess because it is often not separated from other corporate activities, and is sometimes confidential.

Certain private foundations also provide funding. For example, the Devonian Group of Charitable Foundations, in conjunction with the Canada West Foundation, recently supported a study of the water resources of western Canada.

Support for Water Resources Research

Expenditures on water resources research are difficult to assess because of the problem in defining and separating water research from other studies. Nonetheless, a study sponsored by this inquiry provides reasonable estimates of the current research effort in Canada. (1) We have also benefitted from earlier studies of water research activities in Canada. (2)(3)

Table 11.1 shows the funds provided for water-related research in Canada in 1983/84 by each of the major sources. The table also shows the amounts expended by each sector. This comparison reveals the extent to which funds provided by one source are used by another. Notably, the federal government, which is the source of nearly three-quarters of all funding, expends much less than it provides. Universities and industry spend considerably more than they fund.

These estimates suggest that some $56 million was spent on water-related research by all sectors in 1983/84. The federal government accounts for half the total expended, followed by universities, which account for about a quarter of the total. The remainder was expended by provincial governments and industrial organizations.

Our information suggests that the 1983 funding level for water-related research of $56 million rose from $8 million in 1966 (3), implying a seven-fold increase in seventeen years. However, after adjusting for inflation (according to the consumer price index), the real purchasing power of the

funds appears to have less than doubled (from $30 million in 1966 to $56 million in 1983, in 1983 dollars). Although this increase in research funding is substantial, it is less than the increase of 20 percent per year recommended by Bruce and Maasland. (3) Moreover, in terms of constant dollars, research funding has fallen significantly during the past five years.

Since 1966 the proportion of research funding from each of the sources listed in Table 11.1 has also changed. Notably, the federal share increased from 69 to 73 percent and university funding fell from 10 to 3 percent.

In terms of expenditures, the federal share increased from 44 to 50 percent, the provincial share declined from 21 to 13 percent, the universities' share increased by 7 percent and industry's share declined by 4 percent. For reasons mentioned earlier, these figures are imprecise, but they generally suggest that the federal government and universities account for an increasing share of the research effort.

Table 11.2 shows the changes since 1966 in the level of funding for nine general categories of water research. The increasing emphasis on problems of water quality is apparent, with this category alone now accounting for 53 percent of the federal research funding. More than half of the provincial funding is devoted to this category as well. Investigations relating to the water cycle receive much of the remaining provincial funding.

The Federal Role in Water Research

To establish an efficient and well-focused research effort the following questions need to be answered, however tentatively. What are the research requirements for improved water management in Canada? What role should the federal government play in the total water-related research effort? What research studies deserve priority? Is the present effort adequate? Are there adequate scientific and skills to serve the research needs? Is water resources research effectively managed?

To answer these questions, we must begin with the fundamental rationale for the federal government's involvement in water research. It rests, we believe on three responsibilities, each of which implies a different type of research.

First, the government needs research to support its constitutional and legislative responsibilities. This calls for analysis of problems relating to fish habitat, navigation, northern water management and international undertakings, among other things. This research is oriented toward management, so it tends to be applied research. Though some of it may be con-

Table 11.1
FUNDING AND EXPENDITURES ON WATER-RELATED RESEARCH BY SOURCE 1983-1984

Research Sector	Source		Expenditures	
	($ in 000s)	(% of Total)	($ in 000s)	(% of Total)
Federal	40,852	73	28,190	50
Provincial	8,986	16	7,100	13
University*	1,448	3	14,897	27
Industrial	2,390	4	5,632	10
Municipal	930	2	—	—
Foreign	306	—	—	—
Other	907	2	—	—
TOTAL	**55,819**	**100**	**55,819**	**100**

Note: * University expenditures do not include salaries and overhead.

Source: Mitchell, Bruce and Edward McBean. 1985. "Water Resources Research in Canada: Issues and Opportunities". *Research Paper No. 16, Inquiry on Federal Water Policy*. Ottawa.

tracted out, much must be conducted in-house to maintain a basic capability within the federal government itself to respond to the needs of federal managers, to judge the relevance and usefulness of research done by others and to undertake important projects that others are ill equipped to undertake. The latter may include very long-term studies; investigations that must be integrated with governmental field programs; research programs that, because of their equipment or funding requirements exceed others' capabilities; and studies that depend on collaboration among departments or governments.

Second, the federal government is responsible for contributing to improved understanding of natural resources and the environment generally. This responsibility extends beyond the government's particular management needs to the national interest in conserving and developing resources for the long-term economic and social benefit of Canadians. This implies research on the basic nature of aquatic systems and their relationships with land, atmosphere and oceans; investigations into the characteristics of toxic substances and their effects; the role of snow, ice, wetlands and permafrost in hydrologic regimes, and so on. This more fundamental research, can often be suitably undertaken by academic institutions and specialized research centres. But some studies will benefit from the access to information and other agencies enjoyed by government researchers.

Third, the federal government has a responsibility to the national effort in scientific research. This involves supporting Canadian scientists and, to some extent at least, their independent research priorities, and training new scientists. It justifies federal contributions to university researchers through the granting councils and various departments and support for governmental research laboratories. This kind of activity

Table 11.2
CHANGES IN FUNDING FOR VARIOUS TYPES OF WATER RESEARCH, BY SOURCE, SINCE 1966 (ALL DATA IN 1983 DOLLARS)

	Federal		Provincial		Industry		University		Total	
	1966	1983	1966	1983	1966	1983	1966	1983	1966	1983
	($ in 000s)									
Nature of water	87		0		60		0		147	
The water cycle	9,700		3,335		90		710		13,835	
Supply augmentation & conservation	1,350		145		15		15		1,525	
Quantity management & control	800		245		0		0		1,045	
Quality management & protection	5,235		1,030		2,480		160		8,905	
Economic, social, legal & institutional	800		130		0		60		990	
Resources data	1,250		220		45		0		1,515	
Engineering works	1,335		30		320		30		1,715	
Environmental management & protection	0		0		0		0		0	
TOTAL	**20,557**		**5,135**		**3,010**		**975**		**29,677**	

Source: Mitchell, Bruce and Edward McBean. 1985. "Water Resources Research in Canada: Issues and Opportunities". *Research Paper No. 16, Inquiry on Federal Water Policy*. Ottawa.

develops Canada's scientific capabilities, and ultimately lays the foundation for improved resource management.

Fundamental Questions of Research Policy

We are left with questions about how these roles can be adequately fulfilled. First, how much effort should the federal government devote to water research? In 1982, Australia's Water Resources Council calculated various countries' spending on water research as a percentage of their annual capital expenditures in the water resource industry. (4) Canada's 2.8 percent compared with 4.0 percent for the United States, 2.2 percent for the United Kingdom, and 1.4 percent for Australia. However, the estimates of Canada's research expenditures used in this calculation differ from ours, and in any event the ranking is based on a questionable measure of the adequacy of research effort.

Canada is reported to assign 1.3 percent of its gross national product to research. (5) When this percentage is applied to our estimated economic value of water in Canada (See Chapter 4), it suggests that water research funding should be between $100 million and $300 million, compared to our present level of $56 million. But even this is likely to be low since our estimates include the value of water in only certain uses. Moreover, the stated objective for expenditures on research and development in Canada is 2.5 percent of the gross national product, nearly double the present level. (5)

Such rules of thumb for assessing research funding are questionable. The appropriate criterion for judging the adequacy of effort is whether research needs are being met. This cannot be estimated in a general way. It requires individual research needs and program costs to be investigated, and even then depends heavily on expert judgement. It is a task we have been unable to undertake within the scope of this inquiry.

Two other fundamental questions of research policy must be addressed: What is the appropriate distribution of federal research support among in-house establishments, universities and the private sector? What priorities should be accorded to the almost limitless variety of potential research projects?

Determining research priorities is notoriously difficult, but it is essential for governmental agencies. We have identified several topics that appear to call for much higher research priority than they receive at present. These include the impact of persistent and toxic substances on human health and ecosystems; the trends and implications of climatic change; the quantity and quality of groundwater resources; methods of assessing instream needs for water; the value of water in competing uses; the impact of pricing and other conservation techniques; and socioeconomic problems generally. But we have been unable to assess these in the full context of other research needs and capabilities.

Considerable progress has recently been made in developing methods for evaluating research and setting priorities according to defined criteria, but we found no evidence that such systematic evaluations are made of water research programs. (6)

In addition to the need for explicit priorities, water research within the federal government needs to be coordinated. Earlier in this chapter we reported on the water-related research of several departments and agencies. This dispersed activity calls for some coordination.

Attempts have been made to coordinate water-related research, but none has been entirely satisfactory. For example, the Canada Centre for Inland Waters was established in 1966 to consolidate in one place the water research activities of federal departments and to create a national centre of expertise in this field. While the centre has integrated, to some extent, the federal effort in water research, it cannot coordinate all federal water research efforts because some agencies involved in water research are not represented in this institution. Moreover, the centre has been preoccupied with issues specific to the Great Lakes.

The Associate Committee on Hydrology of the National Research Council was established to foster contacts between researchers and others concerned with water and to formulate research priorities. But it confines itself to hydrology to the exclusion of the broader range of research on water quality, health, fish habitat and so on.

The federal Interdepartmental Committee on Water (described in Chapter 14) sometimes discusses research plans, but it does

not attempt to do so comprehensively, and it has not established any subcommittee or other special arrangements for this purpose.

Guidance on Research Policy

To respond to all these fundamental questions of water research policy, a special expert body is needed. For this purpose we propose that a Canadian Water Resources Research Council be created. This council should report to the Minister of the Environment and should assist the Minister in formulating policy regarding federal support of water-related research.

Thus, we recommend:

11.1 The Minister of the Environment should be empowered to appoint a Canadian Water Resources Research Council with terms of reference that direct it to:

- **i) provide up-to-date assessments of the current and emerging needs of water-related research in Canada;**
- **ii) assess the adequacy of financial and other support for water-related research;**
- **iii) offer advice on research priorities and the appropriate distribution of federal research support to federal research centres, universities, provinces and the private sector;**
- **iv) investigate other policy questions related to water research that it considers appropriate or that the Minister may refer to it;**
- **v) report annually to the Minister and issue reports on special subjects as appropriate.**

This council's membership need not be large, but should represent users and researchers and managers in the federal and provincial governments, the universities and the private sector. Some international representation may also be useful. The council should be convened periodically and have a modest secretariat. This structure is similar to that of research councils in fields of forestry and environmental assessment.

The Interdepartmental Committee on Water (discussed in Chapter 14) should be assigned responsibility for coordinating research, among other things, within the federal government itself. In this role, it will benefit from the external advice of the proposed Canadian Water Resources Research Council.

Federal Research Institutes

The role of the federal government's water research institutes should be reconsidered. For example, these centres might be given a geographical, rather than a functional, mandate. Thus, the National Water Research Institute might well become Great Lakes Research Centre and the National Hydrology Reseach Institute might become a Prairie and Northern Rivers Research Centre. Consideration should also be given to the needs in other regions as well, particularly the Atlantic. A review of these possibilities would be timely in view of the National Hydrology Research Institute's imminent move to Saskatchewan.

We are particularly concerned about inadequate provisions for research in Canada on drinking water and drinking water treatment. The mandate of the Wastewater Technology Centre at Burlington could logically be extended to include such research. Thus, we recommend:

11.2 The Wastewater Technology Centre should expand its program to include applied research on the treatment of drinking water.

It has also come to our attention that the laboratories and equipment in the department's research institutes is often not fully utilized, yet access to them by researchers in universities and industrial organizations would be very advantageous. At present, Treasury Board policies relating to commercial use of government facilities impede this kind of external access. We therefore see a need for changes in these policies to facilitate access to governmental research facilities, and we recommend:

11.3 The Treasury Board should revise its policies relating to the commercial use of governmental laboratories and equipment to facilitate their use by outside researchers.

Regardless of their geographical of functional concentration, governmental research programs should be sensitive to the changing needs of policy makers and managers, both within and outside the federal

government, and should be coordinated with other institutes' research activities. Research institutes should carefully assess the relevance of their research programs and maintain communication with resource managers and others who are expected to use the results. For this reason we believe that each institution should have an external advisory board to regularly review its research programs and offer advice on research plans. We therefore recommend:

11.4 An external advisory board should be appointed to assess the research programs and plans of each of the federal water research centres. These boards should report annually to the responsible minister and to the Water Resources Research Council.

These boards should include knowledgeable representatives of provincial governments, university researchers and private organizations concerned with water use and development.

University Research Support

Research effort in a multidisciplinary field like water is likely to be most effective if support is focused in centres of specialized competence, which universities can provide. Such centres recognize the need for continuing commitment to the subject; they enable a group of specialists to be brought together for mutual reinforcement; they provide institutional arrangements to facilitate specialized, advanced studies and they help to concentrate teaching and research in the field. For these reasons, we recommend:

11.5 The federal government should support the development of centres of excellence in water research in universities. These centres should be regionally distributed and each should be encouraged to specialize in a specific, relevant field of water research.

The Westwater Research Centre at the University of British Columbia is an example of a successful centre of this kind. It specializes in water law, water institutions and the social science of water management. New centres in other regions should be encouraged to specialize in other fields. One centre might focus on atmospheric and climatic change, for example.

These centres must be established with great care. Several others supported in the past have failed, apparently because they lacked focus, university commitment or leadership. They must therefore be structured flexibly to build on established strength and administrative competence. And they would benefit from links with nearby federal or provincial research establishments, involving joint projects or personnel exchanges.

The Research Climate

No matter how well organized the research establishment and how well conceived the research plan, the productivity of research effort ultimately depends on the quality of researchers, their motivation and the extent to which they communicate their findings. An atmosphere of scientific excellence is essential to a productive research environment.

We found evidence of low morale within Environment Canada's water research establishment and to some degree among the freshwater research scientists of Fisheries and Oceans. This apparently resulted from an inadequate sense of direction, insufficient funds to permit technological exchange, personnel freezes, reorganizations and recent criticism of the efficiency of water research spending. There is also a more fundamental concern that water research is no longer regarded as important in its own right. Research seems to have been relegated to a technical support service, allowing the scientific base to erode. In the opinion of many, there is overemphasis on research that responds to immediate policy and program needs.

Creation of a stimulating research climate cannot be left to chance; it requires that problems such as those noted above be corrected. It also requires deliberate policy to attract and develop creative and productive researchers, and to take full advantage of their capabilities by ensuring they are supported and motivated.

To encourage scientific development and excellence in research, Environment Canada's science advisor should represent the interests of scientists and researchers to the department's senior management. He should recommend personnel assessment and career development policies.

Another way to provide incentive and direction is to encourage communication between researchers and managers. Government research establishments, particularly, should have close contact with the department's operational programs. This does not mean that researchers should respond only to the immediate demands of managers or to short-term priorities. Research programs should include long-term studies that advance basic understanding and anticipate future problems. However, communication between research establishments and operational programs should be sufficient to keep research activities in perspective and to take advantage of opportunities for collaboration. Our proposals for advisory groups can assist in this, but organizational arrangements will need to be attended to as well. We return to these matters in Chapter 14.

The value of research depends upon communicating its results to those who can use them: other researchers, who can build on the scientific findings, policy developers and the public. In Chapter 16 we return to the question of communicating information about water resources and management issues.

Data Collection

Whether it responds to immediate management needs or long-term scientific interests, research depends on data. So, as the demands on water managers and researchers have increased, so has the need for data.

At one time, visually inspecting water resources provided the information needed to locate water mills, canals and bridges. Industrialization and expanded pressures on resources created the need for more sophisticated data for planning hydroelectric works, providing irrigation, controlling floods, protecting fisheries and so on. Similarly, the need for water quality information became evident when links between pollution and disease, especially typhoid, were established in the last century. Since then, expanding industry, agriculture and population centres have created even heavier demands for data.

We examine here the federal government's water data programs. As pointed out in the preceding chapter, the federal government devotes considerable resources to collecting data on water. Some $45 million and 750 person years are expected to be spent in 1985/86.

Environment Canada supports programs for collecting atmospheric, water supply and water quality data. Other departments with water-related responsibilities collect needed information themselves or obtain it from Environment Canada. Provincial governments collect some of the data they need for resource management through collaborative arrangements with the federal government.

Water Quantity Information

Environment Canada's Water Survey of Canada is responsible for collecting, archiving, distributing, and, to some extent, interpreting most water quantity data. The survey originated in the hydrometric data program initiated by the federal government in 1894, to record stream flows for developing irrigation in Alberta and Saskatchewan.

It operates from regional offices in Halifax, Montreal, Guelph, Winnipeg, Regina, Calgary and Vancouver with a staff of more than 300 engineers and technologists and collects data at more than 3,000 sites or "gauging stations" across Canada. The data are compiled and then stored in the national water data bank, HYDAT.

Most of the data collected relate to river and stream discharges and to the variations in water levels in lakes. Data about river flow velocities, depths and widths, ice thickness and temperatures are also collected, but less consistently. This information is needed to assess flood risks, to design hydraulic structures, bridge crossings and navigational channels, and to undertake various other water-related projects.

The federal government and the provinces share responsibilities and costs under arrangements set out in formal agreements. (7) With the exception of Quebec, these agreements call for the federal government to conduct continuing surveys and to be reimbursed for the provinces' share of the cost. In Quebec, a provincial agency operates most of the stations and is reimbursed by the federal government. The proportion of the cost taken by each government depends on whether the data are of federal interest, provincial interest or joint interest. Federal-provincial consultative committees meet annually to establish

the cost-sharing arrangements and to review the need for each station.

The 1,165 federal stations include:

- those required to fulfill statutory obligations or to support programs of various federal agencies;
- those that monitor waters flowing across or along provincial or territorial boundaries;
- those on streams crossing or forming part of the international boundary;
- those required to define a national inventory of surface waters.

The 829 federal-provincial stations include:

- those where both governments have stated a need for the information;
- those where joint responsibility is established under federal-provincial agreement; and
- those that assess the quantity of water available in distinct hydrologic zones within a province.

The 1,041 provincial stations support specific provincial interests. The network also includes 330 stations not covered by these agreements.

The Canadian Hydrographic Service of Fisheries and Oceans also operates gauging stations. They compile water level, tide and current tables and map all navigable waterways, rivers and lakes. Some information is exchanged with the Water Survey of Canada.

In 1983/84 the Water Survey of Canada expended $21 million, including overhead. Of that amount, $11 million was spent on federal-provincial stations. Almost $5 million was reimbursed by provinces for operations at provincial stations.

Sediment Surveys

Sediment surveys are covered with the cost-sharing arrangements of the federal-provincial water quantity surveys. The present sediment survey involves some 200 stations across Canada, half of which are permanent.

Sediment information is essential for management planning, dredging operations, setting flow regulations forecasting land use impacts on the water regime, identifying sensitive fish habitats and anticipating turbidity problems in water supplies. The program also includes special studies on watersheds, erosion and silt deposition in rivers, and changes in river channels and deltas.

Water Quality Information

The Water Quality Branch of Environment Canada is the principal federal monitoring agency for water quality. Its origins can be traced to a 1934 investigation by the Department of Mines into the quality of surface waters of importance to industry and municipalities. The International Hydrological Decade (1964-1974), coupled with a growing awareness by Canadians of threats to the environment, led to a national water quality monitoring network which, at its peak, included about 1,000 stations.

Following a 1977/78 review and a new federal policy statement on inland waters, the water quality network was restricted almost exclusively to boundary stations and to basin studies that were the subject of formal agreements. Provincial governments were expected to meet their own needs for water quality monitoring on inland waters.

As a result of this change in policy, however, the data collected lacked the consistency required for addressing new Canada-wide issues such as the impact of acid deposition on the aquatic environment. Recognizing this, in 1982, Cabinet authorized Environment Canada to negotiate federal-provincial water quality monitoring and cost-sharing agreements to allow for more comprehensive assessments of water quality both nationally and regionally. Federal interests were defined as international and interprovincial waters, the north, federal lands, toxic chemicals, long-range transport of airborne pollutants, and nutrient controls.

The only federal-provincial agreement in place so far is with Quebec. But negotiations are well advanced with Newfoundland, Alberta and British Columbia.

Today, the Water Quality Branch collects data at 730 stations on rivers and lakes across Canada and analyzes the samples in regional laboratories. It employs close to 140 chemists, biologists, engineers, computer scientists and technical and administrative support staff in this program. Expenditures amount to about $7 million annually. In addition, the federal government transfers more than $1 million to Ontario for its share of monitoring under the Great Lakes International Surveillance Plan.

When agreements have been negotiated with all provinces, the jointly sponsored network is expected to involve 1,800 sta-

tions, with an additional cost to the federal government of $2 million.

Currently, about 500 thousand analyses each year yield quantitative information about constituents in precipitation, surface and groundwaters, wastewaters, sediments and aquatic organisms. Laboratories transfer the data to regional computer systems and to the National Water Quality Data Bank (NAQUADAT), a data storage and retrieval system designed to accomodate both federal and provincial data. After interpretation, the data are published in water quality reports.

Other departments collect data for their specific needs and generally for a short period of time: for example, Health and Welfare Canada currently samples and analyzes drinking water for chlorophenols.

Other Information

The Atmospheric Environment Service of Environment Canada maintains a network of more than 3,000 meteorological stations. Meteorological information most pertinent to water management includes data on precipitation, evaporation, temperature, wind, radiation, and the water content of snow and ice.

The Canadian Glacier Inventory of the National Hydrology Research Institute is conducting an inventory of Canadian glaciers, expected to be completed in 1990.

Data Systems

The federal government operates data management systems used by federal and provincial governments, universities and the private sector. These include the six computer-based data banks listed in Table 11.3.

Table 11.3
WATER-RELATED DATA SYSTEMS MAINTAINED BY THE FEDERAL GOVERNMENT

Data Systems	Data Provided
HYDAT	• Data or streamflow, water levels and sediment transport collected through federal-provincial Water Quantity Agreements
MUNDAT	• Information about municipal waterworks and waste water systems, compiled in cooperation with provincial governments and the Federation of Associations on the Canadian Environment
NAQUADAT	• Water quality data, including chemical, physical, bacteriological, biological, hydrometric data
NIPS	• Inventory of industrial and municipal water pollution sources
	• Water effluent regulations and guidelines
STAR	• Limnological data on the Great Lakes
WATDOC	• Inventory of water-related articles and reports

Source: Environment Canada. 1985. Communications with Environmental Protection Service and Environmental Conservation Service personnel.

Evaluation of Data Programs

In general, the water data programs seem well organized. The Water Survey of Canada and the developing national water quality monitoring network provide the basic elements for a national water data system that can ensure standard sampling methods and consistent information. The cooperative arrangements between federal and provincial governments avoid duplicated effort and promote efficient use of available resources. The cost-sharing arrangements reflect the benefits accruing to each party. And the centralized data storage and distribution systems are clearly advantageous to all users.

Our criticisms of the present arrangements relate to particular components of the data system. First, we are concerned about the slow progress in establishing the water quality data network. This needs more urgent attention, and so we recommend:

11.6 The federal government should maintain a continuing commitment to the Water Survey of Canada and hasten negotiations with provinces and territories to extend the water quality monitoring program nationally.

We are also concerned about the lack of federal attention to groundwater. Although the Geological Survey of Canada investigated groundwater resources as early as the late 19th century, investigations were discontinued when responsibility for natural resources was transferred to the prairie provinces in 1930. As a result, groundwater inventories and assessments of quality and potential yields are uncoordinated.

Earlier in this report we noted the importance of groundwater resources to Canada's water supplies, the interdependence of groundwater and surface water systems, and the emerging problems of managing these resources. For these reasons, we consider this gap in the water survey system should be corrected. We therefore recommend:

11.7 The federal government should seek the cooperation of the provincial governments to extend the water data collection systems to include Canadian groundwater resources.

In the less developed parts of the country, particularly in the north, data collection stations are scarce. Although the federal government has full responsibility for water management in Yukon and the Northwest Territories, the water quality monitoring network has yet to be expanded into those regions. At least a skeletal network is needed to investigate indications of acid rain and other airborne pollutants, to monitor for potential influences of tar sands operations in Alberta, and to maintain long-term surveillance of streams nears abandoned mine sites.

To meet the growing need to predict spring break-up and ice jams, data on ice and snow as well as other data are needed. Data on the role of permafrost and peat in the hydrologic cycle, and atmospheric data on rainfall, temperature and humidities in remote locations are also needed. Thus we recommend:

11.8 Information about water resources in the northern territories should be improved by:

i) extending the national water quality monitoring program to include Yukon and the Northwest Territories;

ii) developing a network of automated data stations and satellite communications in cooperation with the Atmospheric Environment Service.

Recent advances in satellite imagery and automatic data telemetry systems offer particularly promising opportunities for studying such phenomena as glacier dynamics and snow accumulation at low cost. Since both glacial ice and snow are essentially reservoirs of water, data on their condition is valuable to water resource managers. Thus, the opportunities afforded by new technology to improve water monitoring systems should be explored. We therefore recommend:

11.9 Remote sensing and other advanced technologies should be explored with a view to effecting economies and improving information in water quantity and quality monitoring systems.

The experience and expertise of the Atmospheric Environment Service should be drawn upon in exploring these opportunities.

Although the existing data systems are quite comprehensive we have found their potential users often unaware of all the information available, where it may be obtained and the cost. This makes the data less useful. A simple directory is needed of water-related data and information available from federal and provincial sources. We therefore recommend:

11.10 Environment Canada should publish a comprehensive directory of water-related data and sources.

As information systems expand, the value of such a comprehensive reference for academic, governmental and industrial users of data will undoubtedly increase.

Finally, we consider it appropriate to charge users for data and other information provided to them in response to requests. The policies of different agencies within Environment Canada are now inconsistent in this matter. Water survey data are supplied on request without charge, while the Atmospheric Environment Service levies charges in certain cases. The department should adopt a consistent cost-recovery policy. Thus we recommend:

11.11 Environment Canada should review the data distribution policies of its various services with a view toward implementing consistent cost-recovery charges for data provided on request to clients who are not parties to intergovernmental data agreements.

The revenues generated from such charges will help to defray the cost of expanding data-collection programs. Charging for data will also help to ensure that data collected corresponds to real needs.

The coverage and efficiency of data collection programs might be improved in other ways. It might be advantageous to integrate water quality sampling more extensively with the water quantity monitoring network. Suspended sediment analysis might be more meaningful if they were coordinated with monitoring river morphology. Sediment surveys might well be designed to help trace the movement of toxic substances. Certain water quality characteristics such as acidity might be amenable to automatic sensing from existing guaging stations.

We have made little reference to the data collection of other federal departments. Because water is not the focus of attention in other departments, data is collected, if at all, for other purposes, tending to be project or site-specific. Nevertheless there should be a mechanism for coordinating and exchanging information, and the Interdepartmental Committee on Water should assume this responsibility.

Finally, we want to emphasize that we do not support the collection of data for its own sake. As we explained earlier in this chapter, the justification of federal data collection programs lies in providing information needed for management, research and improved understanding of water resources. This means not only that the data collected must be relevant, but also that it is compiled, interpreted, analysed and made available in forms that are useful to those who need it.

Conclusion

In this chapter, we have tried to explain the federal government's important responsibilities in water research and data collection. We believe it should direct its effort more closely to these responsibilities.

Modern problems in water management have broadened the scope of needed water research. Increasingly, we need to understand complex aquatic systems, the full dimensions of the hydrological cycle and its relation to the natural environment, and long-term chemical and biological processes. And in addition to research and data that respond to immediate management problems, we need more forward-looking, anticipatory and speculative research directed toward forestalling rather than rectifying problems.

This makes the management of governmental research particularly difficult. Thus, special effort must be devoted to identifying objectives, weighing priorities and evaluating performance. Techniques are now available for doing this, but apparently the federal government has not used them. Yet such activities are essential for assessing the adequacy of research support and the appropriate redirection of effort.

Chapter Twelve

Water Export

Canada seems to be no more organized today than it was 20 years ago when massive diversion schemes (on paper) created a "crisis" atmosphere.

ONTARIO SOCIETY FOR ENVIRONMENTAL MANAGEMENT

During the last two decades, the possibility of exporting water has arisen repeatedly. Even during this inquiry, new proposals attracted media coverage and, like earlier suggestions, generated considerable debate. In this chapter we review potential export problems and opportunities and their implications for federal policy. This leads us to propose a general approach to this question.

Canada is not yet faced with any firm or official overtures from the United States or any other country to import Canadian water. Foreign demand on Canadian water is, so far, a made-in-Canada controversy. But both Canadian and foreign proponents have been exploring possibilities, and many commentators expect Canadian governments will eventually have to make decisions about specific projects. Therefore, it is appropriate to consider the general question of exporting water and to begin establishing a general policy position.

Our public hearings revealed widespread interest in water export in all parts of Canada. Most of those who commented on this subject opposed exports for reasons we describe below. A few, mainly the proponents of particular ventures, regarded exports as a promising economic opportunity.

The Range of Possibilities

While most media attention has focused on proposals for massive river diversions into the United States, water export possibilities take a variety of forms, some of which may prove more feasible than others. Because their policy implications differ, it is important to distinguish among them.

Local Transborder Supplies

Water supplies may be piped from Canadian border communities to neighboring United States communities, and vice versa, as an expedient means of meeting local needs. Three such arrangements came to our attention, all of which have been operating for some years. In one, the water supply system of Coutts, Alberta, extends across the border to serve local needs in Sweetgrass, Montana. In another, water is supplied from Gretna, Manitoba, to the community of Neche, North Dakota. In the third, water is piped from St. Stephen, New Brunswick, across the St. Croix River to Calais in Northern Maine. Part of this supply is directed back into New Brunswick to serve an industrial operation.

These transborder water systems are small and do not involve interbasin transfers. They are convenient ways of rationalizing local supplies between neighbouring communities and do not invoke questions of national concern.

Tanker Shipments

Recently a new interest has been shown in the possibilities of using ocean tankers to ship water from Canada to foreign markets. A presentation at our public hearings in Vancouver described a detailed proposal of this type. (1) It would involve loading one or two small tankers per week with some 5.4 million litres of water from a coastal stream draining into the ocean from Freil Lake, some 90 kilometers north of Vancouver. The water would be shipped to California or Mexico or wherever a market could be secured, bottled and sold for drinking water. A more recent proposal would involve loading tankers with water from the city of Sept-Iles, Quebec, and shipping it to markets in the Middle East. (2) Several other possibilities are being studied on both the Atlantic and Pacific coasts. To date, however, none of these enterprises has succeeded in finding a buyer.

Like small transborder water supplies, tanker exports on the scale contemplated so far involve almost insignificant volumes of water. They would involve no serious environment disruptions although in certain circumstances they may have implications for

fisheries and navigation, but of a familiar kind. Moreover, tanker exports are unlikely to lead to a dependence on Canadian supplies that implies irrevocable commitments of our natural resources.

Major Transfers

The abundance of water in Canada and the increasing pressure on supplies in some regions of the United States have repeatedly attracted the attention of engineers and planners to the possibilities of diverting Canadian rivers southward. Interest became especially keen after 1963 when the United States Supreme Court restricted California's use of the Colorado River. Many ambitious schemes were proposed to meet California's growing water demands, involving diversions of water from the north and east. In 1968 a variety of political circumstances, including opposition to these ideas from the Pacific northwest states, induced the United States Congress to impose a ten-year moratorium on studies of major interbasin transfers, and this moratorium was renewed for another ten years in 1978. Nevertheless, legislation in 1976 required studies of the Ogallala aquifer and of the transfer of water from adjacent basins. (3)

Table 12.1 summarizes the most notable proposals involving international transfer. Few are supported with technical or economic analysis, and most have dimmed with time. (4)

Some of these proposals are staggering in scale. In 1964 Ralph M. Parsons Ltd, a California engineering firm, conceived the North American Water and Power Alliance, which involved diverting flows from the Mackenzie and Yukon River basins southward through the Rocky Mountain Trench into the United States to provide irrigation water to the southwestern states, to generate hydroelectricity and to create navigation routes. It features a huge new network of waterways throughout the western half of the continent.

A good deal of controversy surrounds the equally massive GRAND Canal scheme, described at our public hearings in St. John's. (5) This scheme, first promoted in 1959, currently involves a dyke across James Bay to entrap the rivers flowing into it from Ontario and Quebec and reversing 17 percent of their flows southward. This flow, roughly equivalent to 30 percent of the discharge of the Great Lakes, would be withdrawn from the freshwater reservoir, channelled through river valleys, reservoirs and pumping stations some 640 kilometers, raised 300 metres over the Canadian Shield and discharged into the Ottawa River. From there, water would be diverted to Lake Huron through Lake Nippissing and the French River, another 180 kilometers. Water from the Great Lakes would then be diverted to the United States southwest and the drier regions of western Canada. Although this project has not been thoroughly analysed, the GRAND Canal Company Ltd. estimates that its construction costs alone would be in the order of $100 billion.

Proponents of this scheme suggest that it would serve a variety of useful purposes: by significantly increasing the flow into the Great Lakes, their levels could be stabilized in the face of growing consumptive demands for water and possible climatic changes that may reduce natural inflows; the additional supplies would improve the water quality in the Lakes, and would provide for irrigation on the Canadian prairies and in the dry United States southwest where groundwater is being depleted.

Critics of this scheme argue that these benefits are speculative, and even its purely economic implications are very unfavourable. Indeed, there is no identifiable market for water diverted to the United States that would recoup the massive capital and operating costs. Moreover, the environmental and social disruption that would result from this scheme would be widespread and uncertain. The proposal involves many times more water than any interbasin transfers recently undertaken or contemplated in the United States; it would alter a vast area of northern Ontario, and the effects of interrupting river flows would be felt on distant fisheries and ocean regimes on the east coast. As well, it would present major problems in controlling water levels and regulating flows in the Great Lakes system.

Large-scale diversions of Canadian waters into the United States raise a number of policy issues not shared by the more modest forms of export referred to earlier. These can be summarized as follows:

- They all involve water transfers from one watershed to another, and in many cases from one oceanic basin to another. The problematical and uncertain ecological consequences of such interbasin transfers

are described in Chapter 10.

- Like other big water-development projects, they involve significant changes to the natural environment by interrupting river flows, flooding, transferring life forms and even changing atmospheric and oceanic conditions. The ultimate consequences of these changes are uncertain.
- They impinge on land and other uses of natural resources and threaten to dislocate established communities dependent on them.
- Their environmental and social impacts must be considered, for all practical purposes, irreversible.
- The capital investments required would be enormous and difficult to predict with precision, particularly given the long construction periods. Moreover, capital costs could be recouped, if at all, only over a long operational period, which presents additional uncertainties about costs, benefits and the future direction of technological change. These complications are aggravated by the international dimensions of these schemes.
- Because of their scale, interjurisdictional dimensions and multiple effects, they call for a high degree of governmental involvement.

Table 12.1
PROPOSED INTERBASIN EXPORTS FROM CANADA

Proposal (Location)	Year Proposed	Water Source	Annual Diversion (km³)	Estimated Construction Cost (billions of $)
GRAND Canal Plan (Ontario)	1959 to 1963	James Bay (Hud. Bay) diverted to Great Lakes and United States	317	100
Great Lakes-Pacific Washington Plan (Dorsey)	1965	Rivers, Mackenzie & Fraser of B.C., Peace, Athabasca, Saskatchewan of Prairie Provinces	140	Not Available
North American Water & Power Alliance (NAWAPA) (Ontario)	1964 1973	Yukon, Mackenzie (Hot Prairie & Arctic Basins) of Alaska, Yukon and B.C.; also Athabasca of Prairie Provinces	410	100
Western Plan (Magnuson)	1966	Peace, Athabasca & N. Saskatchewan in Alberta	31 44 billion	Not Available
Rivers Plan (Hedges)	1967	Peace, Athabasca & N. Saskatchewan in Alberta, Nelson & Churchill in Manitoba	165	30
[illegible]	1967	[illegible]	135	[illegible]
[illegible]	1968	[illegible]	40	[illegible]
[illegible]	1968	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

- Because they involve overland water diversions across the border, they invoke our established arrangements with the United States under treaties and international law for managing international waterways.

Foreign Demand For Canadian Water

Several long-term trends in the United States have stimulated an interest in diverting Canadian water. First, water demand in the western United States continues to grow due to expanding irrigation and rapid urban population growth (Arizona's population increased by more than half during the 1970s, and Nevada's by more than two-thirds).

At the same time, the availability of unused water in parts of the United States is declining. The Colorado River is already overallocated. Moreover, the lower reaches of this river have become so saline due to irrigation that the United States has had to install a half-billion dollar desalination project to restore the water quality to the standard required to meet its commitments to Mexico. In addition, the huge Ogallala aquifer, the most important source of groundwater in the United States, is being depleted, threatening the extensive agricultural industry in the high plains that has grown dependent on it. (6)

Notwithstanding these developments, some experts believe that a significant need for Canadian water by the United States is a distant prospect for two reasons: demand management and conservation policies could eliminate the need for new sources; and large-scale transfers of Canadian water are economically infeasible. Currently, the United States uses only 31 percent of its available supply. By the end of this century it will probably still be using less than half, even without new conservation policies, and only 11 percent will be consumed. (7)

Various schemes for recharging the Ogallala aquifer with water from other basins have been considered by the United States Army Corps of Engineers and other investigators and have been found economically impracticable. These include diversions from Lake Superior and Lake Erie as well as the diversion of Canadian water from James Bay and northwestern Canada mentioned earlier. (8)

Demand management policies, involving conservation measures and user fees, are expected to be effective in gradually adjusting demands made on the Ogallala aquifier to correspond more closely to the available supplies. (9) And several southwestern states are embarking on vigorous water conservation programs. California is using statutory means to reduce municipal water consumption. Arizona is metering wells, levying fees for water withdrawn and charging higher prices for irrigation water supplied through the new Central Arizona Project. Arizona has also overridden an old law that tied water rights to landholdings, so that agricultural landowners can transfer water rights to municipal utilities and other more valuable uses. (10)

Moreover, court rulings in the United States have denied the states the right to prohibit water transfers to other states. This implies greater flexibility in redistributing water within the United States itself.

Studies suggest that if reliance is placed on transferring water from elsewhere, some 20 percent more water would be required to restore the Ogallala aquifer than if measures were taken to control the growth in demand. These transfers would probably cost $500 to $1,500 per thousand cubic metres for delivery just from Missouri and Arkansas River reservoirs to the Ogallala states; distribution costs within these states would probably double these figures. Delivery costs from a source as far away as the Great Lakes would be an additional $500 per thousand cubic metres even without any allowance for compensation to existing users of those waters.

The difference between the cost of providing irrigation water and the price charged for it in the United States southwest is striking. In California's Central Valley, for example, the average price paid by farmers in 1981 was $6 per thousand cubic metres while the marginal cost of supplying it was as high as $350. These arrangements have been sustained with massive federal subsidies. But there is increasing political resistance to these heavy subsidies which, if reduced, would go a long way to alleviate impending shortages of water.

Finally, even if Canada afforded the least costly source of water for the arid southwestern United States, which appears unlikely, it would almost certainly cost more than $1,300 per thousand cubic metres

to deliver. To agricultural users, who account for most of the demand, the water would be worth less than $130 per thousand cubic metres. And under current arrangements, they actually pay less than a tenth of this figure. (9) Indeed, modern technology may be capable of providing desalinated sea water from the Pacific or the Gulf of Mexico at no greater cost than diversions from Canada. For all these reasons, the economic foundation for large-scale diversions of Canadian water to the United States appears doubtful.

The potential markets for water shipped by tanker are quite different. Some proposals are intended to take advantage of oil tankers returning empty to the oil-rich desert countries of the Middle East. Instead of taking on sea water as ballast, they could carry freshwater. Other proposals involve tankers dedicated to carrying freshwater.

According to some estimates, the cost of desalinated sea water in the Middle East is in the order of $4 per cubic metre. The cost of loading and transporting Canadian water may be close to $2 per cubic metre on a backhaul from oil delivery or slightly under $3 in a tanker dedicated to hauling water. (11)

However, these proposals face a number of problems. First, Canada is less well situated to serve the world's arid regions than some other potential sources of freshwater supply. Nor do we receive much oil from the Middle East, compared with many other countries. Second, water delivered in oil tankers for drinking purposes would have to be processed to remove oil residues or the tankers' holds would have to be fitted with bladders to protect the water from contamination. In addition, costly loading and unloading facilities would have to be installed. These and other problems are being investigated in Canada and elsewhere.

Regulatory Arrangements and Policy

We have already noted that the provinces have constitutional authority to issue rights to use water within their boundaries. All of them, and the northern territories, have well-developed arrangements for licensing users of water. So the first thing that must be emphasized in discussions about regulatory policy for water exports is that any proposal, before it can proceed, must meet the approval of the relevant provincial governments or territorial water boards. These authorities can be expected to take account of the proposal's potential impacts, beneficial and adverse, within their jurisdictions.

Among the provinces, British Columbia and Alberta appear to have articulated the clearest policies toward water exports. In 1979 Alberta formally opposed water export in its water management principles. (12) British Columbia has also opposed proposals for massive water diversions to the United States, but it has welcomed opportunities to store water and harness transboundary rivers within the province in return for payments for hydroelectric and flood control benefits accruing downstream in the United States. With respect to bulk tanker shipments, it has specified the considerations to be taken into account in reviewing applications for licences. And it has recently set a schedule of fees to be charged for such water.

The federal government also has considerable control over water exports. First, as described in Chapter 7, the *Fisheries Act* gives the federal government broad powers for controlling alterations in waterways that support fisheries. None of the massive diversion schemes could escape this regulatory power and the need for Minister of Fisheries approval. Second, because overland diversion schemes alter natural watercourses, they would usually need to be approved by the federal Minister of Transport under the *Navigable Waters Protection Act*. Third, most international diversions can be expected to involve international rivers, which are regulated under the federal *International River Improvements Act*. And finally, they will usually involve international waters subject to special treaty arrangements or international law, both of which fall under federal authority. While these are powerful regulatory powers, they are constrained by the particular purpose set out in the relevant legislation or international accords. At present, no federal legislation deals specifically with water exports.

During debate in the House of Commons, federal resource ministers have, over the years, consistently opposed the export of Canadian water. However, this policy has never been formally codified.

Recently, the eight United States Great Lakes states and the provinces of Ontario and Quebec signed the Great Lakes Char-

ter. Although this accord is not binding on either federal government, it calls on the signatories not to approve any significant increase in water consumption or diversion from the Lakes without seeking approval from the other signatories. (13)

Additional Policy Considerations

There are also other possibilities that some commentators regard as at least tantamount to water exports. Our Boundary Waters Treaty with the United States (discussed in Chapter 8) assures the two countries equal rights to the use of boundary waters. In this framework, does the present United States consumption of Great Lakes water at a level many times that of Canada's consumption constitute an export? Is there any fundamental difference between committing water to export and committing water to the generation of electricity which is then committed for export? Is the export of water embodied in the production of aluminum, food and wood products, beer and other beverages somehow different in its policy implications from exports of raw water? These questions help to focus attention on the need for consistency in our approach to water exports within the broader scope of international trade policy.

Public opinions on the question of water exports are often strongly held. Recently, several prominent public figures have suggested that water exports, including large-scale diversions to the United States, offer considerable economic opportunities for Canada.(14) Most of those who addressed the subject at our public hearings opposed the idea, often vigorously.

Our concern about these expressions of opinion is that they are, unavoidably, reactions to hypothetical propositions. We have no significant experience in exporting water, nor do we have thorough analyses of possible projects. To some extent, at least, opinions divide along the lines of proponents of development and proponents of environmental protection. The public interest lies in careful consideration of the arguments of both.

Proponents of export schemes claim that water exports would produce economic benefits in the form of income generation, employment, regional development and possibly beneficial impacts on our balance of payments. These effects are amenable to analysis and, as we have suggested earlier, the cost and benefits of any major water development project should be rigorously assessed.

Many of the anxieties about water export schemes are similar to those about other water development projects. These involve concerns about environmental disruption, social dislocation, and the risks and uncertainties inherent in such projects. These, too, warrant careful assessment, as we advocate in Chapter 10.

The unique concerns about diversions for export are more difficult to assess. They include fears that commitments may be difficult to terminate, and thus will prejudice future Canadian needs. These fears are aggravated by the threat of long-term climatic changes that may alter Canadian needs in unforseeable ways. Some Canadians resist, for nationalistic reasons, arrangements that would increase the interdependence of Canada and the United States. And some oppose, in principle, the sale of water on grounds that it is an integral element of the Canadian environment and should not be considered a commodity of trade. (15)

As we emphasized at the outset, water evokes special feelings among Canadians. On the surface, it appears unreasonable to object to exporting a renewable resource like water while supporting exports of nonrenewable resources like minerals, coal and natural gas. The explanation lies, at least in part, in the special heritage value that many Canadians attach to our water resources.

An Approach to Federal Policy

All these considerations lead us to advocate a cautious approach in developing federal policy toward water exports. We should be prepared for proposals in forthcoming years, but we cannot now predict their frequency or variety. Nor can we predict whether they will be beneficial to Canada or not. We have therefore concluded that it would be imprudent for the federal government to reject all exports out of hand. In any case, sustaining such a position, regardless of the opportunities and against private and provincial government interests, would be difficult, as was illustrated in the controversy over electricity exports in the early 1960s.

A policy on water export should clearly

set out the conditions that must be met for any proposal to be acceptable. Since provinces license water uses within their boundaries, these federal criteria should emphasize considerations of federal and national concern. These include among other things:

- impacts on fisheries, navigation, federal waters and international and interjurisdictional waters;
- international economic, political and strategic considerations;
- implications for the ability of available water supplies to meet long-term Canadian requirements, taking into account uncertainties about these requirements and the cumulative effects of exports on a regional and national scale;
- regional environmental and economic effects;
- implications for the interests of native and other social groups, and the adequacy of compensation for adverse effects;
- the general economic advantages to Canada.

Specification of criteria based on these considerations calls for political guidance and so they should be determined in a political forum.

In addition to specifying criteria for acceptability, the government should set out clear procedures for assessing export proposals. The procedure should include explicit arrangements for proponents to seek project approval, for the government to deal with them and for the public to assess them. The federal and provincial governments will need to collaborate in this matter since, in almost all conceivable cases, proposals will require provincial approval.

To effect these arrangements, the federal government will need legislative authority to review water export proposals. We therefore recommend:

12.1 The federal government should pass legislation to require anyone who proposes to export water to obtain a licence. This legislation should identify the matters that will be taken into account in considering a licence application.

These considerations should include those noted above. Such provisions are similar to those in the *National Energy Board Act* relating to approving applications for permits to export energy.

This licensing requirement will be sufficient to enable the Minister to review small-scale export proposals, such as those involving tanker operations and small transborder water supplies. As long as a proposal does not have significant implications for any of the specified considerations, and has already been approved by the relevant provincial governments, the licence could be granted.

We conclude that there is no reason for the federal government to oppose tanker exports in general. The Government of Canada should regulate them, but in the absence of any significant adverse effects of particular proposals, it should not prohibit them.

Interbasin transfers to the United States are an entirely different matter and require very careful consideration.

First, a political determination should be made as to whether the Government of Canada is prepared to entertain such proposals and, if so, under what conditions. Accordingly, we recommend:

12.2 The Cabinet should determine whether the government is prepared to consider large scale diversions of water to the United States and, if so, the criteria that must be met for approval of proposals.

If diversions involving exports are to be considered, the Cabinet should specify how proposals will be assessed (according to the considerations noted in the legislation recommended earlier) within a general benefit-cost framework to establish whether they will advance the overall Canadian interest.

Finally, if the government is prepared to consider diversions to the United States, the legislation providing for federal approval should include special provisions for assessing large-scale projects. These assessments can be expected to be infrequent, but they should be thorough and their procedures well understood in advance. We therefore recommend:

12.3 For the purposes of assessing water export proposals having significant environmental, social or economic implications, the Minister of the Environment should be empowered to appoint a special review panel for each proposal. These panels should:

i) **consist of members appointed, in part at least, in consultation with governments of provinces or territories directly affected by the project;**
ii) **investigate the full range of matters that the Minister must review in considering an application for an export licence, according to criteria determined by the government;**
iii) **receive information and analysis from relevant governments and agencies, as well as from the proposal's proponents and other interested groups;**
iv) **consider feasible modifications of the proposal in terms of scale, characteristics and time of construction;**
v) **hold public hearings where no other suitable provisions are made for the public to review its implications for the interests of Canadians;**
vi) **publicly report its findings, with recommendations about whether the licence should be granted and, if so, what terms and conditions should be attached to it.**

In general, the applicants should be required to bear the costs of assembling the information required for these assessments, unless a special public interest is involved.

We consider it important that the government resist pressures to support any large international diversion scheme, at least until these recommended arrangement are in place. In Chapter 10, we noted that flows into the Great Lakes may ultimately need to be augmented in view of increasing water consumption and possible climatic change. (16) This potential, long-term need warrants study, but it should not be addressed in the context of any particular proposal for water export.

The debate about water export and diversions, which has been gathering momentum, distracts us from the job of managing Canadian water in Canada for Canadians. Our recommendations are intended to put this debate in perspective and to clarify Canada's policy. We believe that these arrangements will, as far as possible, ensure that the broad national interest is protected in assessing water export proposals.

Part V

Water Management in Northern Canada

Chapter Thirteen

Water Management in the Territories

If there is one word that can be used to characterize northern water resources, then surely that word is "opportunity"... Here, there is still every opportunity to do things right the first time, to learn from the mistakes made elsewhere, and to develop innovative ways to respond to complex water issues.

NORTHWEST TERRITORIES WATER BOARD

Yukon and the Northwest Territories have a unique place in Canada's national mosaic. They are the home of less than one in every two hundred Canadians, but they are vast, covering more than 40 percent of Canada's land mass. And they are particularly important to this inquiry because they contain roughly 30 percent of all the freshwater in Canada.

Several other characteristics of the northern territories have led us to devote a special section to them. First, unlike the rest of Canada, the federal role is not restricted by provincial constitutional authority, so federal responsibilities are broader and different. Moreover, the federal government has committed itself to devolution, that is, delegating its powers to the territorial governments. We have had to take this into account in our recommendations.

Second, while similar federal statutes and administrative structures apply to both territories, their cultural and social characters are as strikingly different as their physical features, though this is not widely appreciated by southern Canadians.

Third, policy making in the north must take special account of northern aboriginal people, who not only comprise a large proportion of the population but also have a special interest in their natural resources, because their lifestyle depends on them. As well, native land claims remain unsettled.

Fourth, public participation in policy making is highly conspicuous. Extensive public hearings have preceded major policy decisions on such matters as pipelines, land use and offshore petroleum development. And unique provisions are made for public consultation in allocating water rights and controlling water quality.

Finally, the north is in an early stage of economic and social development. This affords an opportunity to take advantage of the mistakes and successes experienced elsewhere.

The Policy Framework for Water Management

When Canada acquired the northern territories from the Hudson's Bay Company in 1870, ownership of their natural resources passed to the federal Crown. And management responsibility was assigned to the federal government, currently to the Department of Indian Affairs and Northern Development. During the last fifteen years, new legislation has broadened the statutory base, new administrative structures have been created, and the process of transferring responsibilities to territorial governments has begun.

Federal legislation and Administrative Responsibilities

Most federal legislation bearing on water management within the provinces applies to the northern territories as well. The scope of these major statutes is described in Chapter 7.

General federal legislation. The *Fisheries Act*, is administered by Fisheries and Oceans Canada, though the important pollution control provisions are enforced jointly with the Environmental Protection Service of Environment Canada. The Act's prohibition against disturbing fish habitat has proven particularly contentious in the regulation of Yukon's placer mining industry.

The *Navigable Waters Protection Act* protects navigation, and the *Canada Shipping Act* controls pollutant discharges from shipping. Navigation in Yukon is presently limited to small recreational craft, though large paddlewheel vessels regularly plied the Yukon river until the 1950s. In the Northwest Territories, the Mackenzie River

supports significant commercial traffic, much of it carrying bulk petroleum products.

Parks Canada, under the *National Parks Act* manages water within the five northern national parks. The *Migratory Birds Convention Act* and the *Canada Wildlife Act* protect waterfowl habitat and are administered by the Canadian Wildlife Service in cooperation with the territorial ministries of renewable resources. Health and Welfare Canada monitors and controls the quality of community water supplies.

The *Canada Water Act*, administered by Environment Canada, provides for federal cooperation with provinces and territories in studies, plans and programs for managing water systems.

Federal arrangements specific to the north. The *Northern Inland Waters Act*, passed in 1970, is the most important federal legislation for managing water resources in the northern territories. Following the *Canada Water Act* of 1970 and the *Arctic Waters Pollution Prevention Act*, it considerably broadened the statutory base for water policy in the north.

The *Northern Inland Waters Act* provides a unique framework for managing water resources. Among other things, it establishes a water board in each territory, which is responsible for conservation, development and use of water resources.

Because of their central role in managing water resources in the north, we examine them in some detail later in this chapter.

The federal Department of Indian Affairs and Northern Development, administers the *Northern Inland Water Act* under two programs: the Indian and Inuit Affairs Program, and the Northern Affairs Program. The first, which accounts for some 80 percent of the department's budget, deals with economic and social problems of native people. Its concern with water extends to water quality and the threat of contaminated water to the health of native people.

The second, the Northern Affairs Program, is more specifically concerned with managing natural resources. It regulates land use and resource development either directly or in collaboration with other agencies. In addition, it provides financial support to territorial governments for public services provided elsewhere in Canada by provincial governments. And its Water Resources Division plays a major role in water management. This agency is responsible for enforcing the *Northern Inland Waters Act* and resource planning; providing engineering advice to the department and to the water boards; forecasting floods; collecting data; and providing information to water users, the water boards and the general public.

In both territories, this division shares responsibility with the Water Survey of Canada for the hydrometric network that monitors flows on *major* water courses. In addition, it operates a hydrometric network that monitors stream flows on *small* drainage basins. It shares the responsibility for collecting water quality data with Environment Canada.

The Role of Territorial Governments

At present, territorial governments are responsible for managing wildlife, recreation and tourism, and for providing community water and sewage systems. They also recommend appointments to territorial water boards. And they are expected to have a broader influence on managing and developing other natural resources through their participation in new land use planning arrangements.

So far, little territorial legislation relates to water resource management. The *Environmental Protection Act*, enacted in 1973 by the Northwest Territories is an exception. This Act empowers the territorial government to monitor and regulate pollution discharges although it cannot control activities authorized under any other territorial or federal legislation. Some confusion exists about the division of responsibilities between Environment Canada and territorial officials. Therefore, the territorial government is considering changing the legislation.

Cooperative Studies and Planning

The Yukon River system and the Mackenzie River system have both been subjects of river basin studies under the provisions of the *Canada Water Act*. The Mackenzie study, completed in 1981, investigated the hydrology of the river system, flood dangers, environmentally sensitive areas, and socioeconomic needs and concerns among other things. Three federal departments, the territorial governments and the three provinces that share the Mackenzie

basin participated in the study. The federal government bore more than three-quarters of its $1.6 million cost.(1)

The Yukon River Basin Study, at a cost of $2.2 million, was undertaken between 1981 and 1984. Environment Canada, Department of Indian Affairs and Northern Development, Yukon and British Columbia all participated. Program study areas included hydrology, energy, fisheries, wildlife, placer mining, tourism, parks and recreation, water quality and socioeconomic concerns.(2)

The final report has not yet been published. But we expect, like the Mackenzie River Study, interjurisdictional cooperative agreements will be highlighted in its recommendations.

Arrangements for land use planning in the north are still being developed. On July 15, 1981 the Federal Cabinet Committee on Social Development authorized the Department of Indian Affairs and Northern Development to develop and implement a Land Use Planning Process for the north. Two years later, the Department of Indian Affairs and Northern Development reached agreements with both territorial governments and native organizations about cooperative structures and processes for land use planning. However, federal concern about how these agreements affect the division of responsibilities between the federal and territorial governments delayed their implementation. In the Northwest Territories, this has been resolved through a 1984 letter of understanding between the federal and territorial governments, and land use planning is about to begin. In Yukon, the issue remains unresolved.

Water Boards

The Northwest Territories Water Board and the Yukon Water Board are unique institutions in Canada. Their innovative structure, responsibilities and procedures appear well suited to the territories' conditions. The boards have been involved in all major developments in the north, and they have a remarkably high public profile. However, there is continuing debate about which agency should take the lead role in water management; the water boards, the Department of Indian Affairs and Northern Development or the territorial governments.

Mandate

The water boards are to:

> . . . provide for the conservation, development and utilization of the water resources . . . in a manner that will provide optimum benefit therefrom for all Canadians and for the residents of the . . . territories in particular. (3)

Two features of these terms of reference deserve emphasis. First, the "conservation, development and utilization" provision has a broad enough scope to enable quantitative and qualitative aspects of water management to be managed under one licensing system and by one decision-making body. This allows the boards to take into account the interdependence of water quantity and quality. Second, the "optimum benefit" objective has enabled the boards to allocate water flexibly according to its highest use in particular circumstances, in contrast to the rigid ranking of priorities common elsewhere. Both these features are highly desirable.

The board's major task is to set licence conditions and issue licences, which are ultimately approved by the Minister of Indian Affairs and Northern Development. But after licences are issued, the Water Resources Division of the Department of Indian Affairs and Northern Development is responsible for enforcing their conditions.

In addition to issuing licences, the boards can make recommendations to the Minister of Indian Affairs and Northern Development about establishing water management areas and land reserves to protect water resources, about water use priorities and about water quality standards. They may also recommend that water licences be suspended in an area pending comprehensive planning. Finally, the boards are authorized to hold public hearings on any of these matters.

Water management areas have been established in both Yukon and the Northwest Territories, but the other powers have not been exercised. Some commentators believe this has left a vacuum in water management policy in the north.(4)(5)(6)

Licensing Procedures

In both territories, a water licence is required for depositing any waste material into water and for all except minor water

uses. When an application for a licence is received, it is reviewed by a group of technical advisors. If it considers the application acceptable, the board holds a public hearing on it. After the hearing (unless the application is denied), the board reviews the application in light of the arguments presented, sets appropriate terms and conditions, and sends a draft licence to the Minister for approval. The Minister has never denied a licence submitted by either board.

The two water boards face quite different social, political and economic situations. Much of the history and social structure of Yukon has been shaped by the placer mining industry, which had its roots in the gold rush of 1898 and operated for many years in a largely unregulated climate. The management of water licences for placer mining is one of the most sensitive issues facing the Yukon's Water Board. The Northwest Territories has no placer mining. The population is mostly natives, who depend on water resources to maintain their traditional lifestyles. And unlike Yukon, it has a nonpartisan government.

Several differences in water licensing practices have arisen from the different circumstances in which the boards operate:

- The boards have different methods for coordinating technical advice.
- In the Northwest Territories, the Controller of Water Rights monitors unlicensed minor water uses through land use permits. In Yukon, the mining industry is exempt from land use permits, so the board has no means of monitoring minor water uses in mining.
- In the Northwest Territories, draft licences are prepared by the Technical Advisory Committee and circulated to interested parties before being sent to the Minister. In Yukon, draft licences are prepared by water board staff and are not circulated.
- In Yukon, the water board prepares *Reasons for Decisions*, which become part of the Water Use Register (a public file); in the Northwest Territories, this is not done.
- In Yukon, the water board usually cancels a public hearing if no interventions are filed; in the Northwest Territories, the water board usually holds a hearing whether or not interventions are filed.
- In the Northwest Territories, the water board usually invites a community representative to sit with the Technical Advisory Committee while a licence affecting the community is being reviewed. In Yukon, this is not done.
- In the Northwest Territories, notices of public hearings and hearing transcripts are translated into the native language and sent to communities. In Yukon, this is not done.

The Northwest Territories Water Board has never had conflicting applications and has never denied a licence. But the Yukon Water Board has had to choose among conflicting applications and has denied licences for a variety of reasons including possible conflicts with existing users, inadequate investigation by the applicant, and failure to meet basic water quality standards for effluent discharges.

Table 13.1 summarizes the licences issued in recent years. In the Northwest Territories, most licences issued are for industrial purposes (principally mining), community water supply and sewage treatment systems; a number are also issued for hydroelectric developments. In Yukon most licences issued are for placer mining.

In contrast to practices in most provinces, water licences issued in the two territories have a specific term. A licence may be renewed, but the user must file an application for renewal. This provides another opportunity for public participation and enables the water board to review the licence conditions.

Regulating Minor Water Uses

The *Northern Inland Waters Act* empowers the Governor-in-Council to exempt minor users of water from the licence requirement. Until 1984, the Controller of Water Rights (Regional Manager, Water Resources Division, Department of Indian Affairs and Northern Development) issued authorizations for minor uses under this provision. Minor uses include those involving less than 225 thousand litres per day, uses for periods of less than 270 days, engineering uses, municipal uses in unincorporated areas, among others. These authorizations were an expeditious way of providing for many minor and routine water requirements. They were also important in the overall water management system. Some 550 authorizations were issued in the two territories in 1983 compared to 18 licences. (See Table 13.1)

In Yukon, authorizations were used to respond to the water needs of several

hundred (mostly small and seasonal) placer mining operations. In addition, the water board attempted to develop guidelines for the placer mining industry. A series of public hearings were held between 1972 and 1975 but were inconclusive. In 1979 the water board again attempted to deal with guidelines for placer mining through public hearings, but because they proved to be divisive and confrontational, they were adjourned and the issue was passed to the Minister of the Department of Indian Affairs and Northern Development for resolution.

In 1976, the water board established other guidelines to assist the water controller to help him with issuing authorizations to placer mining operations. Guidelines were also established to deal with priorities among placer miners to ensure that those operating under short-term authorizations would have their rights renewed the following season.

The discretionary nature of the system established by the 1976 guidelines led to criticism from the mining industry and hostility towards federal officials. By the early 1980s, both the appropriateness and the legality of the authorization process for the placer mining industry were being questioned.(7)

Meanwhile, the Dene and Metis were also questioning the authorization process as it was used in the Northwest Territories. They objected to the discretionary power of the controller to determine, not only whether an application would require a licence or an authorization, but also whether any terms or conditions should be attached to it to provide for environmental protection.

When the Dene challenged the legality of the authorization process, the court held that the process did, indeed, exceed the statutory authority of the act and so was illegal.(8) Within hours of this decision the federal cabinet passed new regulations that dispensed with the authorization process entirely and exempted most minor uses of water from any form of regulation. Significantly, however, the new regulations require placer mines to obtain water licences.

Under the new regulations many water users must judge for themselves whether they need a licence, but this is often uncertain. In addition, without the records formerly provided by the authorization process, the water boards and other agencies are left with incomplete information about water uses in their respective territories. This makes it difficult for them to allocate and manage water resources in a comprehensive manner.(9)

In an attempt to overcome this problem, both boards ask that all water users file an application, so that the boards can decide whether or not a licence is appropriate. However, not all users who believe they are exempt will do so. In the Northwest Territories this difficulty is alleviated because

Table 13.1
WATER LICENSES ISSUED AND OUTSTANDING IN THE NORTHERN TERRITORIES

	Yukon				Northwest Territories			
	licenses issued			licenses active in	licenses issued			licenses active in
Use	1982	1983	1984	1984	1982	1983	1984	1984
Placer mining	—	1*	268	278	—	—	—	—
Industrial*	1	3	1	11	2	6	—	15
Municipal	2	3	1	10	1	4	2	16
Power	1	3	1	6	1	—	—	9
Agriculture	—	—	—	1	—	—	—	—
TOTAL	**4**	**10**	**271**	**306**	**4**	**10**	**2**	**40**

Note:
* Until late 1983, licenses issued in Yukon for placer mining were classified as "industrial". Industrial in Yukon also includes hard-rock mining, bucketline dredging, fish hatchery and recreation (hot springs). In the Northwest Territories, "industrial" includes pipelines, oil and gas industry and mining.

Source: Yukon and Northwest Territories Water Boards files.

the controller receives copies of land use permits issued by the Territorial Land Use Committee. Since virtually all land uses require permits, these enable the controller to monitor minor water uses. Moreover, he may suggest conditions on the permit regarding water use. In Yukon, the *Placer Mining Act* and the *Quartz Mining Act* specifically exempt both placer and hard rock mining operations from land use permit requirements, so this mechanism is not available to monitor minor water uses.

However, the revised regulations do *not* exempt minor users from the requirement to obtain a licence to discharge wastes. Thus, all placer miners intending to discharge waste now require a licence. So in 1984 the Yukon Water Board was suddenly inundated with hundreds of applications from placer mining operations.

The arrangements for minor water uses are obviously unsettled and contrary to effective resource management. Apart from the difficulties described above, the present process does nothing to respond to the concerns the Dene had when they initiated the legal challenge to the former authorizations, that is, the controller's discretionary powers.

The revised policy should adhere to certain principles. First, *all* water allocations should be covered by some form of authorization. Second, the complexity of the review process should be commensurate with the potential impact of the proposed water use on the environment and other users. This implies a less formal, more expeditious procedure for most minor uses than the full licensing and public hearing processes required for major uses. Third, the uses that may be exempted from the licensing procedure should be clearly indicated in regulations.

Fourth, the water boards should be notified of applications for minor uses as well as applications for major uses; and they should be empowered to require licences for minor uses in sensitive circumstances or when, for other reasons, they consider the full licensing process to be more appropriate.

Fifth, the process for dealing with minor approvals as well as licences should be open to public scrutiny and responsive to the concerns of interested parties. Sixth, to protect users, minor approvals should have the same legal status as full licences. Finally, both major and minor licences should be recorded in the water boards' record books and be available to the public for inspection.

With these needs in mind, we recommend:

13.1 The arrangements for authorizing minor water uses in Yukon and the Northwest Territories should be thoroughly revised and clarified in consultation with the territorial water boards and other interested parties. New procedures should ensure that:

- **i) all uses of water are authorized in some way;**
- **ii) the complexity of the procedure for processing applications for minor water uses is commensurate with their importance;**
- **iii) those water uses that may be exempted from the full licensing procedure are clearly identified in regulations;**
- **iv) the water boards have the power to require a full licensing procedure when they believe it appropriate;**
- **v) procedures for approving minor as well as major uses are open to the public and responsive to their concerns.**

Expedited procedures for licence applications in the Yukon

The sudden onus on the Yukon Water Board to deal with large numbers of licence applications from the placer mining industry in 1984 induced the board to seek more expeditious licensing procedures. "Draft Rules for Expedited Procedures" are being reviewed by the Department of Justice and Privy Council, and have yet to be approved, but the water board is already using them. These procedures allow applications to be processed without a public hearing; where hearings are held, statements are limited to 10 minutes each and no cross examination is allowed; and most of the application review and information exchanges must be in writing.

Because of these streamlined procedures, the number of hearings held by the Yukon Water Board has increased little in spite of the enormous increase in licences issued (see Table 13.1).

The relationship between the proposed "expedited" procedures and the standard rules that govern the usual board hearings is unclear. Nor is it clear how applications

are to be channelled into the regular or expedited process. Given the long history of controversy surrounding the environmental impact of Yukon's placer mining industry, and the urgency of establishing an efficient and fair process for dealing with large numbers of water licence applications, we recommend:

13.2 The federal Department of Justice should complete its review of proposals for expediting public hearing procedures for water licences in Yukon as a matter of urgency. Before being adopted, revised procedures should be subjected to public commentary from the placer mining industry and other interested parties.

Ultimately, the best solution to the problem of licensing minor water uses may be amendments to the *Northern Inland Waters Act* and Regulations to provide for a variety of procedures that could be suited to the uses being considered. In any case, the new arrangements must be designed in cooperation with the water boards and those who will have to implement them, particularly the territorial governments, who will be expected to carry increasing responsibility for water management.

Notwithstanding the problems we have discussed, we have the general impression that the licensing arrangements in both territories are working well. Certainly, the procedures for dealing with licence applications for major water uses enjoy wide support.

Board Membership and Appointments

Each board has nine members appointed by the Minister of Indian Affairs and Northern Development. Today, three members of each board are recommended by the territory's Commissioner-in-Council, three represent the general public, and of the remaining three, one comes from the Department of Indian Affairs and Northern Development, one from Health and Welfare Canada, and one from Environment Canada. The chairman is a representative of the local community.

The departmental members have indefinite terms, which usually continue until the individual leaves the department. The other members are appointed for renewable terms of one to three years.

Several concerns relating to board membership should be resolved. One is the question of federal representation on water boards. Some commentators have suggested that federal departmental membership should be gradually reduced as the federal government transfers responsibilities to the territories. Furthermore, their representation on the boards can be seen to be in conflict with their ability to participate in the boards' public hearings. Moreover, as long as federal departments are represented on the boards, the question remains of which departments should nominate members. Fisheries and Oceans Canada, for example, is not represented, but it likely has as much interest in water licensing as some of the departments that are represented. Another concern is whether members from federal departments are intended to serve as independent experts or as departmental spokesmen. Finally, the question as to whether members should have some expertise in water management should be resolved.

We believe these problems should be resolved in consultation with those involved. We therefore recommend:

13.3 The Minister of Indian Affairs and Northern Development should prepare a position paper on the boards' membership, taking into account the process of devolution of responsibilities, and the responsibilities of its members. He should seek comments from the water boards, federal government, territorial governments and the public before adopting a final policy.

The water boards are becoming independent of the federal government. In addition to halving federal representation in 1977, they now employ a modest full-time staff instead of using personnel from the Department of Indian Affairs and Northern Development; and they have recently established offices physically separate from the department's.

We support this growing independence of the water boards, which is consistent with their quasi-judicial role. However, an efficient licensing system will require close communication with the Water Resources Division of the Department of Indian Affairs and Northern Development as long as it is responsible for enforcement through initiating prosecutions for infractions.

Technical Advice

To properly evaluate water use applications and set appropriate licence conditions, the water boards require competent technical advice. Technical advisors are provided primarily by the Water Resources Division of the Department of Indian Affairs and Northern Development, but other government agencies participate as well.

In 1973 the Northwest Territories Water Board established a Technical Advisory Committee, chaired by the Controller of Water Rights and comprised of representatives of federal and territorial agencies, industry, communities, private citizens and independent experts. The committee reviews licence applications and submits the recommendations to the board. Any dissenting member may submit a minority report. After a public hearing, the committee drafts a licence, which the board reviews. The committee also reviews studies submitted as part of licence applications, and prepares guidelines for the board on special topics.

The Yukon Water Board originally set up subcommittees to seek technical advice and to prepare draft licences for review. The subcommittees obtained technical advice mainly from the Water Resources Division but also consulted with other agencies, the applicant and outside experts. Discussions were held in closed meetings and the information used was not made public. Arguing that the board was a quasi-judicial body subject to legal rules of fairness and absence of bias, the Yukon Conservation Society in 1982 successfully challenged this system in court.(10) As a result, the board disbanded its subcommittees, ended the participation of board members in closed meetings, and since then has communicated with its advisors and applicants individually, usually in writing. The correspondence forms part of the Water Use Register, a public document. As this report was being written, the board appointed a technical advisor to be their primary source of advice.

Whatever process is used to obtain technical advice on water use applications, we believe it should meet certain criteria in accordance with the principles we set out in Chapter 1. First, in making decisions about water licences, water boards should have access to all available information and to competent professional and technical advice, both from government agencies and from outside experts. Second, information the boards use to set licence conditions should be accessible to the public. Third, the procedures adopted by the boards for assessing water use applications should be clear and open to public scrutiny.

We therefore recommend:

13.4 The water boards should review their procedures for obtaining technical and administrative advice about water licence applications to ensure that they are thorough and open. Their procedures should be set out in a public document.

Charges for Water

Throughout this report we have advocated the principle that the value of water, and the cost of providing it to users, should be reflected in charges for water used. In Chapter 10, we describe the features of an appropriate water pricing system and suggest an approach for determining suitable rates. While the Northern Inland Waters Regulations (Section 10(1)) sets out nominal rates for specific uses, they are not consistent with our recommendations in Chapter 10.

We therefore recommend:

13.5 The Department of Indian Affairs and Northern Development, in consultation with the territorial water boards, should review the fees charged for water used under water licences in the territories, and adopt a systematic procedure for determining water charges.

Responsibilities for Planning

Though the *Northern Inland Waters Act* authorizes the water boards to make recommendations to the Minister on a range of policy and planning matters, the Yukon Water Board has limited its activities to public hearings on guidelines for municipal sewage disposal and on water use in placer mining. The Northwest Territories Water Board has held hearings only on fish contamination in the Hay River. It has also prepared guidelines for municipal wastewater discharges and is currently drafting guidelines for mine tailings dams. These modest activities illustrate the limited extent to which the boards have hitherto exercised their advisory powers beyond water licensing.

Opinions about the water boards' appropriate role in policy and planning vary widely. Some believe the boards' powers are limited to licensing, cancelling licences for infractions, and providing advice on regulatory matters, while the Department of Indian Affairs and Northern Development is responsible for policy, planning, inspection and enforcement.

Others argue that the boards' statutory authority to advise on water management areas, quality standards, use priorities and so on, as well as their power to hold public hearings on these matters, imply a significant role in water planning. Because of the trust and respect the boards have acquired in both territories, considerable support for this view exists, especially in the Northwest Territories.(5)(11)

The prevailing uncertainty about responsibility for policy and planning is a serious impediment to progress in water resource management in the territories. We consider this a matter of fundamental importance that should be clarified without further delay.

In any case, the water boards potentially have an important role in the planning process. Because they have access to water information and to expertise in water use, and because they can hold public hearings, the boards are in a position to make a considerable contribution to the planning process. For these reasons we recommend:

13.6 The federal government, in consultation with the territorial governments and native organizations, should clarify responsibilities for initiating and carrying out land and resource management plans in the northern territories. These arrangement should recognize:

i) the need to integrate water planning with the planning for land and other natural resources;

ii) the mandate of the new Land Use Planning Commission and the Department of Indian Affairs and Northern Development for coordinating resource management in the north, and the process of devolution;

iii) involvement of the water boards in both designing and implementing the plans that they will use for guidance in issuing licences.

Of course, territorial governments, other federal departments, native organizations and the general public should have an opportunity to contribute. The water boards' public hearings could enable this public input.

With responsibilities clarified, the agencies involved should be encouraged to address the planning problems that have been brought to our attention, including:

- protection of instream uses;
- procedures for determining water use priorities in relation to the use of land;
- water quality standards for various uses;
- arrangements for monitoring mining and other industrial operations;
- provisions for mine abandonment and reclamation;
- protection of groundwater from industrial contamination.

Special Management Problems

Several specific problems regarding water resource policy and planning were raised at our public hearings. These call for some commentary here.

Instream water uses

The water licensing system regulates physical uses of water and waste discharges into it, but it does not deal directly with the navigational, recreational, aesthetic, environmental and related values of water. Because these instream water uses are particularly important in the north, some commentators have expressed concern that the regulatory system does not adequately provide for them.

Regulations pursuant to the *Northern Inland Waters Act* provide for licensing conservation uses; this mechanism could be used to preserve waterways in their natural state, but no conservation use licences have yet been applied for. The Northwest Territories Water Board has imposed minimum stream flow and quality conditions in recent licences, but this does not provide for a comprehensive watershed approach.

The lifestyle of northern residents, particularly native people, depends heavily on natural waterways and the fish and wildlife they support. Northerners also depend heavily on water for transportation and recreation. Furthermore, the natural, wilderness environment, of which water is an integral part, gives the north much of its appeal to both residents and other Canadians. Even more, the fragile ecology of the

north cannot sustain normal development without special precautions.

Beyond this, many northerners are anxious to protect the natural environment for its own sake. Thus, two of the principles enunciated at the beginning of this report —that water management should aim at maintaining the productivity of natural systems and that the intrinsic value of natural water regimes should be recognized —apply with special force in the north. The policy question is how best to protect these intangible values.

Ideally, water management policy is based on integrated resource plans, by watersheds, that take into account all needs and values. Instream uses, and the environmental, aesthetic and other intangible values involved, should be recognized in these plans as constraints on other water uses. The licensing system can best be used to allocate rights within these constraints.

To clarify this matter, we recommend:

13.7 Resource and land use plans for the territories should recognize instream uses and the values associated with natural water systems in determining objectives for flows and water quality in each watershed. Water boards should use these objectives as guides in licensing water uses and waste discharges.

This implies a planning and management regime that is beyond present capabilities for all watersheds, and in many cases beyond present needs as well. But it should be aspired to and progressively implemented.

Mine Abandonment

Mining makes a major contribution to the northern economy. Several large-scale mines and a larger number of small operations provide the economic base for communities in both the Northwest Territories and Yukon.

Disposal of mine tailings presents a serious environmental problem. Toxic chemicals can be transported from these wastes through surface water, groundwater, the atmosphere and biological systems. Disposing of mine wastes in ways that will prevent water pollution throughout the operation of the mine and long after it is abandoned is costly and requires sophisticated advance planning and engineering.

In the past, remote mines were often permitted to operate under relaxed environmental standards. This has produced lingering problems and is no longer an acceptable policy.

Existing policy suffers from some deficiences. Government environmental protection regulations are almost entirely devoted to surface water, while groundwater is neglected. This gap is particularly serious in light of the long-term threats of mine tailings. In addition, some uncertainty exists about the responsibilities of mine operators for controlling water pollution during and after operations. This uncertainty includes responsibilities for appropriate operational design, operational controls, site rehabilitation and financial guarantees.

Additional uncertainties surround the responsibilities of government agencies for long abandoned mines that are found to present environmental risks (such as the former Rae Rock Uranium Mine in the Northwest Territories). The Water Resources Division of the Department of Indian Affairs and Northern Development, Environmental Protection Service and Health and Welfare Canada all appear to have some responsibilities, but they are not clearly defined. To resolve these problems we recommend:

13.8 The federal government should appoint a special task force to investigate the environmental problems associated with mine abandonment in the northern territories and means of dealing with it. This task force should:

- **i) include representatives of territorial governments, Environment Canada and the Department of Indian Affairs and Northern Development;**
- **ii) consider, among other things, the planning, management and financial arrangements and guarantees needed to ensure the environmental safety of mine wastes after operations cease; the appropriate terms and conditions of water licences to provide for these matters; and the assignment of governmental responsibilities for dealing with potential or actual pollution from mines already closed;**
- **iii) produce a paper with recommendations on these matters**

for review through the territorial water boards public hearings before a policy is adopted.

We are impressed with some of the provisions of the water licence issued to the Cyprus Anvil Mining Corporation for a new tailings disposal site near Faro, Yukon. They include water quality standards for both surface and groundwater during and after operations, an approved mine abandonment plan with financing proposals and a security bond, and obligations on the licensee to maintain the rehabilitated site after the mine has closed. Other suggestions for dealing with long-term, unforseeable threats from old mines include a protection fund, along the lines of the claims fund established under the *Canada Shipping Act*.

Yukon Placer Mining

One of the most complex and sensitive water management issues in the north is the regulation of the Yukon placer mining industry. This industry inevitably disturbs waterways and adjacent lands, and threatens fish habitat. Its effects have led to considerable controversy in the Yukon River system, particularly where salmon migration routes and spawning beds must be protected.

During the last decade, much effort has been directed to establishing an appropriate water management regime for the placer mining industry. In 1983, the Minister of Indian Affairs and Northern Development struck a public review committee that made recommendations on this matter. (7) Since then, the industry, government departments and the Yukon Water Board have cooperated in implementing measures to mitigate environmental damage from mining operations. As a placer mining company reported to us:

> Positive steps have been made to minimize the conflict between various federal jurisdictions, and the procedures required to obtain a water licence to placer mine have greatly improved. Now the regulatory terms under which the placer mining industry is going to operate have to be resolved.(12)

While we recognize the recent progress, much remains to be done. How the placer mining industry is to be regulated within the broader context of land and water management remains to be determined, yet this is critical to Yukon's entire resource management regime. We emphasize the importance of this problem for water management, and urge the parties involved to maintain their efforts to resolve it.

Hydroelectric development

Most of the electricity supplies in Yukon and the Northwest Territories is produced by the Northern Canada Power Commission, a federal Crown corporation. Some 80 percent is produced through hydro generation.

The opportunities for additional hydroelectric development in both territories are enormous. The Mackenzie River alone is estimated to have a development potential of some 14,000 MW, more than the total present installed capacity west of Ontario.(1) And some 11,000 MW are believed to be available in Yukon. However, many members of the public oppose hydroelectric mega-projects in the north, mainly on environmental grounds, and positions are polarized.

Throughout this report we have emphasized the need for integrated resource planning and management that recognizes all the potential uses of water resources. Thus, we concur with the opinion of the Northern Canada Power Commission that "comprehensive management plan or policy for the northern water resource must fully recognize the enormous remaining potential for hydro power development".(13) Planning and policy development should consider all options, not only those that are favoured at a particular time.

However, we want to emphasize as well another principle we have advocated in this report; namely, that the intrinsic value of natural water regimes should be recognized and costs of irreversibly disturbing the natural environment should be considered.

In short, to refuse to consider hydroelectric opportunities in the north would preclude the kind of comprehensive approach to resource management that we advocate. However, evaluation of potential hydroelectric projects must rigorously take into account the full range of environmental and social impacts.

Political Developments in the North

We have already referred to the rapidly

evolving political circumstances in the northern territories. Two processes are likely to have particularly important implications for water policy: settlement of aboriginal rights and the transfer of governmental responsibilities to territorial governments.

Aboriginal Rights

Native people play a much more prominent role in the north than in other parts of Canada. A quarter of Yukon's residents and more than half of those in the Northwest Territories are indigenous. In recent years, native people have begun to participate much more actively in public affairs, and they have assumed positions of leadership in both territorial governments.

Native people are determined to assert their interest in water resources and to participate in managing them. In doing so, they seek to protect their distinctive way of life and to determine their own future. But they also see their participation in resource management as a means of contributing to Canada's future.

For these reasons, water and water management are important issues in negotiations over land claims between the federal government and native groups. The federal government has explicitly recognized the native peoples' aboriginal interest in water, but regards the water itself as part of the public domain. (14) This is reflected in the one land claims agreement that has been concluded so far. That agreement, with the Inuvialuit of the western arctic, states that the Crown retains ownership of all waters in the settlement region and the right to control water and the water beds in order to manage fish and migratory birds, to carry out projects needed for transportation and navigation and to protect community water supplies. But the agreement grants the Inuvialuit ownership of the water beds and the right to participate with the federal government in water management.

Negotiations over land claims are proceeding with three other native groups: the Dene Nation, the Tungavik Federation of Nanavut and the Council of Yukon Indians. Water management is an important issue in these negotiations as well. (15)(16)

The recently proposed Indian Self Government Act (Bill C-52) set out procedures for Indian nations to acquire substantial legislative and managerial authority over water. In fact, it would have enabled Indian governments to enact legislation that would take precedence over federal and provincial laws in defined areas. Though this act was not passed, continuing negotiations between the federal government and Indian organizations may lead to new dimensions in the jurisdictional complexity surrounding water resources.

The settlement of native land claims is well beyond this inquiry's terms of reference, but we want to emphasize the importance of these settlements for water policy and management in the north. Effective water management depends on careful planning and strict regulation. But the needed institutional arrangements and procedures can only be determined when the rights of various interests are clearly established. (17)

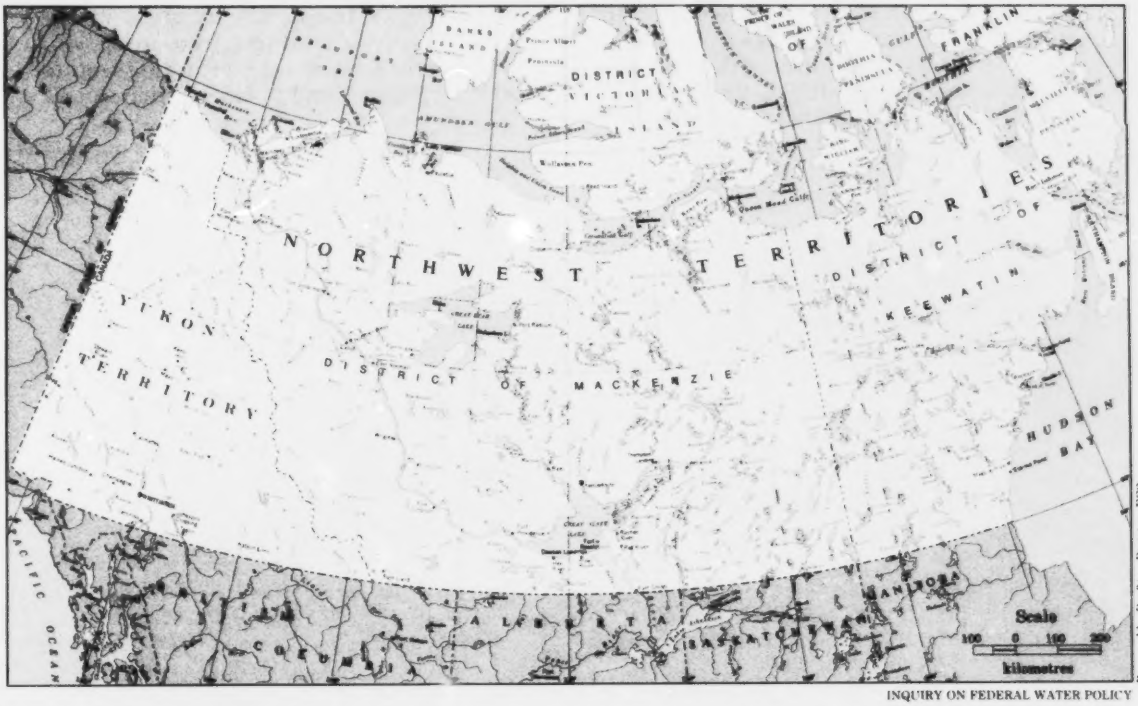
Transfer of responsibilities to territorial governments

The federal government currently favours an organized, gradual transfer of legislative authority over northern land and resources to the territorial governments. And the territorial governments advocate "a phased transfer of responsibility for water resources management". (5) Some observers urge caution in transferring responsibilities until land claims and the question of dividing the Northwest Territories are settled. But, in general, this devolutionary process has broad public support, and both orders of government are now pledged to proceed. These changing circumstances create a special need to maintain close liaison and cooperation.

Other Northern Concerns

Some of the matters we deal with in other chapters have particular relevance to the north. Yukon and the Northwest Territories are each dominated by a huge river system with interjurisdictional dimensions, a subject we deal with in Chapter 7. The Mackenzie River basin is shared by the three western provinces as well as Yukon and the Northwest Territories. The Northwest Territories contains nearly half the basin, but it feels vulnerable because it is downstream from the other jurisdictions and because it contains only 10 percent of the basin's sparse population. Most of these residents are natives living in small communities along the river and its tributaries and fol-

Figure 13.1
MAP OF THE YUKON AND NORTHWEST TERRITORIES



Source: Adapted from map produced by Surveys and Mapping Branch, Department of Energy, Mines and Resources, Ottawa.

lowing traditional lifestyles, which depend on the natural water regime.

The construction of the Bennett dam on the Peace River, the apparent interest in damming the Liard River in British Columbia and Alberta's interest in damming the Slave River have left many of these downstream residents feeling "helpless and vulnerable and desperate". (15) The government's failure, so far, to negotiate an interjurisdictional management arrangement for the Mackenzie system contributes to this anxiety.

Yukon's situation is quite different: three quarters of its territory lies in a headwater position in the Yukon River system.(See Figure 13.1) Still, interjurisdictional cooperation is needed to deal with concerns about proposals to divert headwater lakes in British Columbia, storage dam projects on Atlin Lake and the potential movement of mine effluent from British Columbia into Yukon.

Our recommendations in Chapter 7 are designed to ensure that interjurisdictional conflicts within Canada are resolved as far as possible through agreement among the jurisdictions directly involved. We consider cooperative arrangements for the Mackenzie River to be particularly urgent.

We detected a surprisingly strong opposition in the northern territories to water exports, particularly to interbasin diversions of northern rivers southward to the United States of the kind envisioned in the North American Water and Power Alliance. In Chapter 12 we have recommended a general approach to water export policy.

Finally, we should emphasize the special importance attached to public participation in natural resource management in the territories. It has become clear to us that a major strength of the present water management system is in the support it enjoys from the entire spectrum of the northern community. That support reflects mutual

respect between decision makers and the interested public, which in turn is fostered through constructive public participation.

The intimate relationship between northern people and their natural environment, referred to at the beginning of this chapter, leads inevitably to a direct, personal concern for the way land and water are managed, a need to be kept informed, and a desire to participate in decisions. In the changing political, economic and social circumstances of the north, progress in the management of natural resources will undoubtedly depend on continuing organized consultation and public participation.

Part VI

Structures and Relationships

PART VI
STRUCTURES AND RELATIONSHIPS

In Part VI we examine how the federal government is organized to deal with its responsibilities in water management, with special attention to the central role of Environment Canada. We emphasize the importance of coordinated working relationships among federal departments concerned with water, and between the federal government and the governments of the provinces and territories. We also draw attention to the growing importance of public participation in government decision making about environmental matters.

Chapter 14 deals with the administration, organization and support of the federal government. Chapter 15 examines the various federal-provincial agreements dealing with water resources, and suggests improvements in these arrangements. Chapter 16 considers how public participation and advice can be channelled into the decision making process.

Chapter Fourteen

Administrative Organization and Coordination

Institutions must be made to flow with the progress of technology and society, not to dam it.

ONTARIO SOCIETY FOR ENVIRONMENTAL MANAGEMENT

The way the federal government organizes itself to administer and develop its water policy has emerged as a major issue in this inquiry. Commentators in our public hearings consistently criticized the fragmented administrative responsibilities, the diffused authority and accountability, and the inadequate coordination. These criticisms came from provincial and territorial governments that share responsibilities for water management, private interest groups that want to communicate with federal authorities, industrial and other organizations that are subject to regulations, as well as federal agencies themselves.

Responsibilities for water are highly dispersed among governments and among departments of the federal government. This makes it difficult to administer a coherent water policy, and it explains much of the confusion.

Our recommendations in previous chapters call for a more deliberate and clearly focused federal approach to its water-related responsibilities. This requires a coherent administrative framework, clear lines of authority within the public service, and coordinated activities among agencies. These are the subjects of this chapter.

Roles and Structures

Within a large public service, an agency's appropriate structure depends not only on its purpose, but also on the organization and functions of other agencies. We therefore begin this discussion by describing the roles the federal government must play in water management.

The federal government has a constitutional responsibility to perform four major roles. First, it must manage the resources and activities over which it has direct jurisdiction. This includes its broad responsibilities for resources in the northern territories, fisheries, navigation, international waters and so on.

Second, the federal government has a role in protecting the natural environment in Canada generally. While respecting the provinces' constitutional authority the federal government must set minimum standards, and monitor and regulate within the scope of its own legislation.

Third, the federal government has a role in research, collecting data and disseminating information. These functions support federal management responsibilities and advance our knowledge and management capabilities generally.

Finally, the federal government must encourage others to preserve and enhance water resources by providing information and guidance, advocating and supporting needed changes, and ensuring equitable resolution of disputes among other jurisdictions in Canada and with the United States.

These general roles encompass the water-related programs we have discussed in preceding chapters. The federal administrative organization must therefore be designed to perform them.

Environment Canada

We have identified twenty-two federal departments and agencies with a significant interest in water. Environment Canada, Fisheries and Oceans, Indian Affairs and Northern Development, Agriculture, Transport, Health and Welfare and the International Joint Commission are only the more obvious.

The major responsibility for federal water policy rests with Environment Canada, which administers 45 percent of all federal expenditures on water. Our attention therefore focuses on this department.

Present Structure

In Chapter 2 we described how the government's increasing concern with environmental problems led it to create the

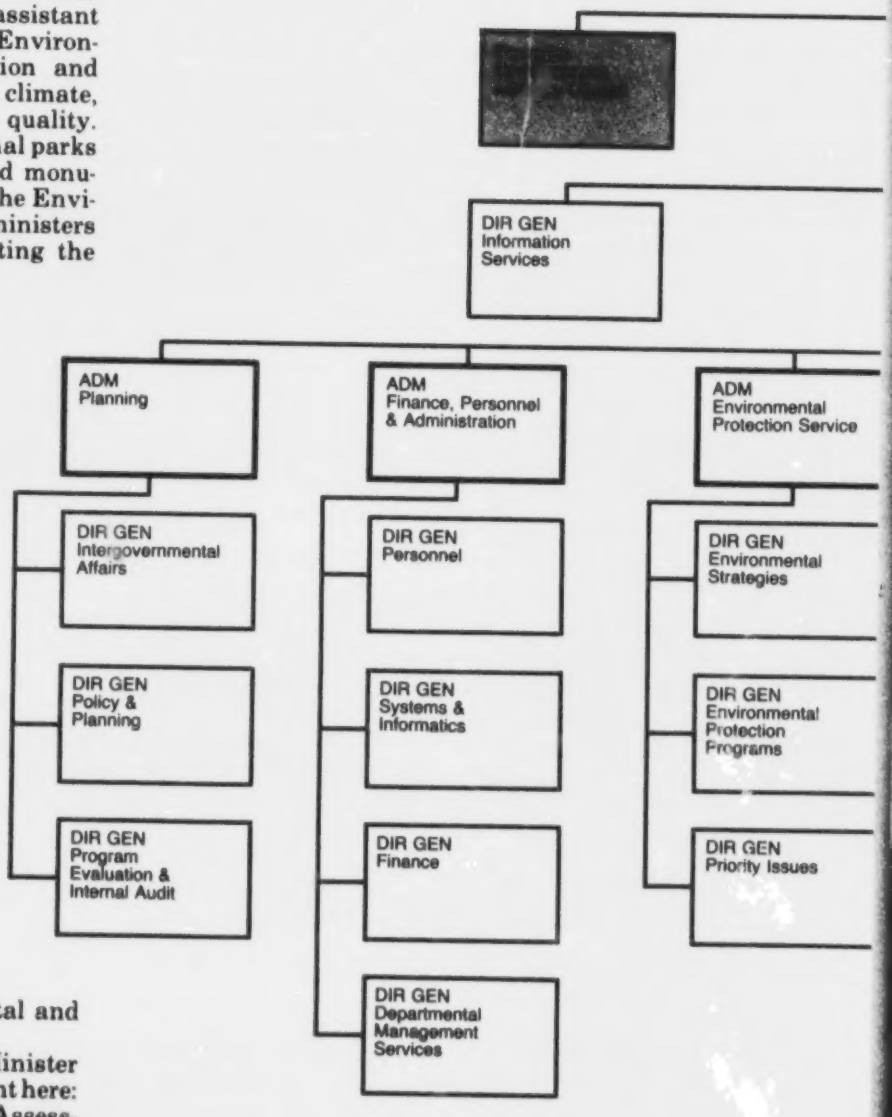
Department of the Environment in 1971. The intent was to bring together in one department most of the agencies with environmental responsibilities. Since then, the department has been repeatedly and substantially restructured, leaving the present organization shown in Figure 14.1.

Four services now exist within Environment Canada, each headed by an assistant deputy minister. The Atmospheric Environment Service provides information and other services relating to weather, climate, the state of the seas, ice and air quality. Parks Canada manages the national parks system, national historic sites and monuments, and heritage waterways. The Environmental Protection Service administers federal responsibilities in protecting the environment from pollution and takes the initiative on priority problems such as acid rain and toxic substances. The Environmental Conservation Service develops policies and programs related to lands, wildlife and inland waters.

As well as these service components, the department contains three support groups: Corporate Planning; Finance, Personnel and Administration Services; and the Information Directorate. It also has a science advisor, who provides information and advice on scientific matters and maintains liaison with governmental and external scientific groups.

Four bodies report directly to the Minister of the Environment; two are important here: the Federal Environmental and Assessment Review Office and the Canadian Environmental Advisory Council. The former reviews project proposals of federal government departments that have significant environmental implications. Its review panels hold public hearings, evaluate evidence, and make recommendations to the

Figure 14.1
DEPARTMENT OF THE ENVIRONMENT 1984



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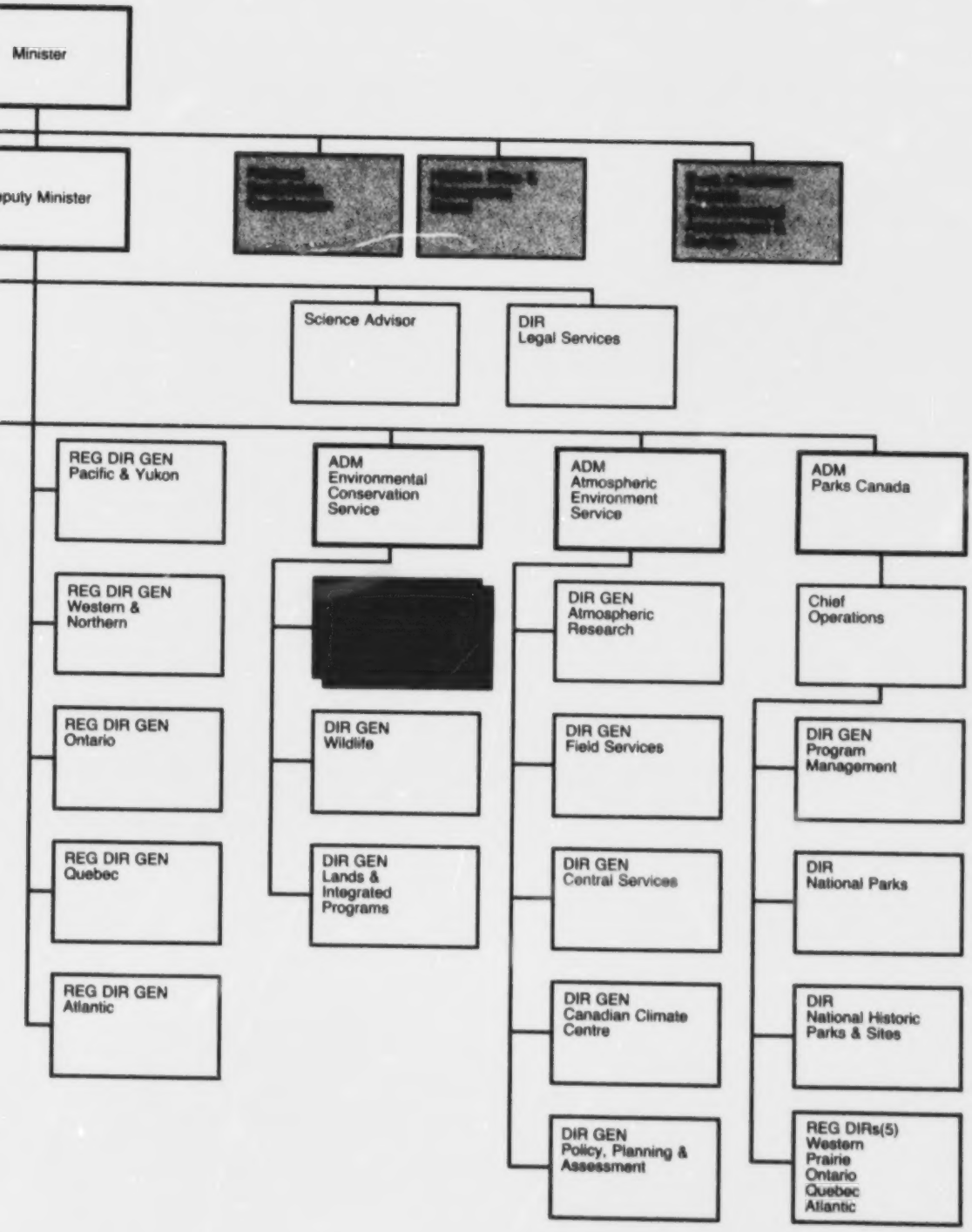
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Minister for appropriate action. The Canadian Environmental Advisory Council provides the Minister with external advice on a wide range of environmental matters. We examine this council in detail in Chapter 16.

In the mid 1970s the Department of the Environment established regional offices in Halifax, Sainte-Foy, Toronto, Edmonton and Vancouver, as well as smaller offices in other centres. The regional offices were to make the department more sensitive to regional concerns and to improve communication with provincial governments and other regional organizations. The presence of a senior official, in the position of regional director-general, enabled more decisions to be taken in the regions.

In the early 1980s another important change took place: the Environmental Protection Service was reorganized to accommodate a shift in its role from simply enforcing regulations related to air and water pollution, to dealing with issues such as acid rain and toxic substances.

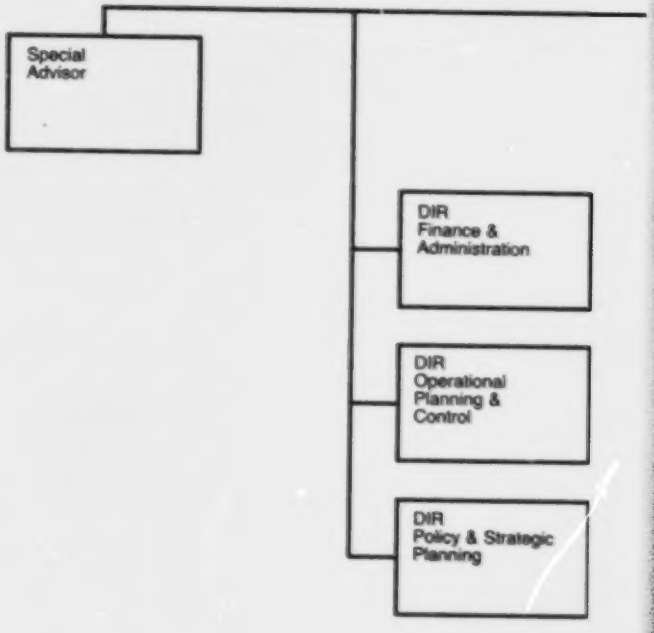
The agency of particular importance to this inquiry is the Inland Waters Directorate of the department's Environmental Conservation Service. This directorate is headed by a director-general and the headquarters is responsible for research coordination, program evaluation and finance and administration. It includes two research institutes — the National Water Research Institute and the National Hydrology Research Institute, described in Chapter 11 — and three major program branches (as illustrated in Figure 14.2) The Water Quality Branch provides data on water quality and information on waters of national interest. It also negotiates water quality agreements with provinces. The Water Resources Branch manages the Water Survey of Canada and investigates water resources through its hydrology division. The Water Planning and Management Branch undertakes water planning and studies, flood damage reduction and international programs.

The Inland Waters Directorate also provides guidance to its regional directors in the regional offices, though they report through the department's regional directors-general.

Deficiencies

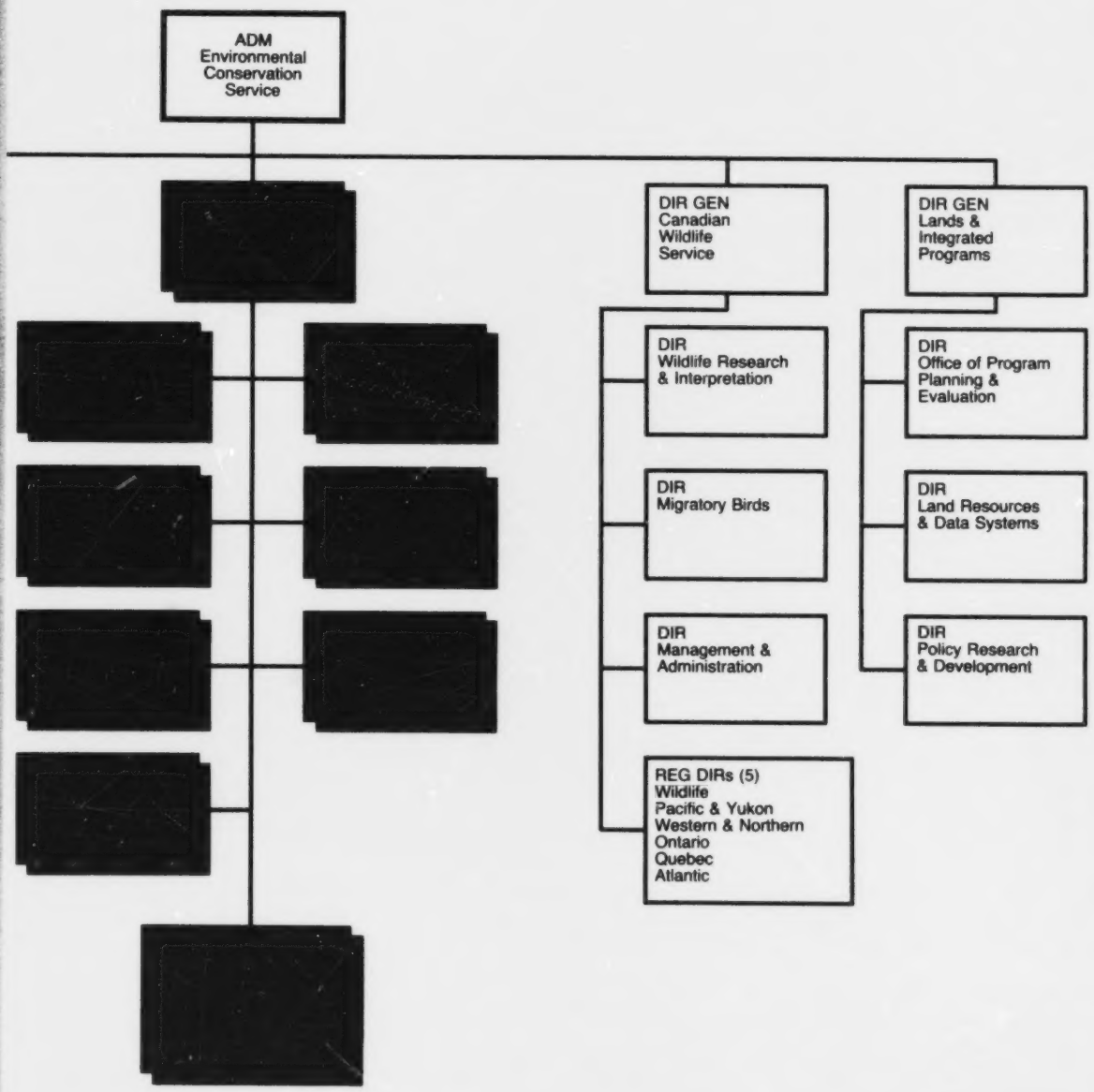
We find four general deficiencies in the federal government's organizational structure. First, it does not give water policy and

Figure 14.2
DEPARTMENT OF THE ENVIRONMEN



Prepared by Drafting Division, IUS

VIRONMENTAL CONSERVATION SERVICE, 1984



administration sufficient status or influence within the federal government. Indeed, the status of water administration has been lowered since 1971 when the Water Sector was moved to Environment Canada from the Department of Energy, Mines and Resources where it was headed by its own assistant deputy minister. The key agencies are now small parts of a relatively modest department. If the federal government is to strengthen its role in water management and ensure an influential water policy, it will need to heighten the profile of water administration.

Second, responsibility for developing and administering the federal government's water policy is diffused. The Inland Waters Directorate has never been explicitly designated as the government's lead agency for water policy, nor has it taken vigorous initiative in this role. A need exists for clearer political responsibility and a recognized lead agency with well-defined objectives.

Third, federal water programs and administration are poorly coordinated. This must be rectified to improve administrative efficiency, to avoid conflict and to address new environmental problems with a concerted effort.

Fourth, some anomalies exist in the administrative structure of Environment Canada. The five regional directors-general report directly to the Deputy Minister, while the director-general of the Inland Waters Directorate reports through an assistant deputy minister. Moreover, while the director-general of the Inland Waters Directorate is expected to provide direction to regional directors-general, he is not a member of the department's Senior Management Committee. These arrangements impede his ability to influence senior management in Environment Canada and other departments.

These deficiencies are closely related and should be dealt with together.

Organizational Alternatives

To carry out its responsibilities in water management, the government could organize itself in many ways. At one extreme, it could create a department of water resources and make it responsible for all water policy matters. This would raise the profile of water administration and maximize coordination. For such reasons some commentators suggested this arrangement.

However, we have concluded that it would be impracticable to create such a department. The federal government is not primarily responsible for water management and those water responsibilities it does have must be managed in the interests of navigation, agriculture, fisheries, public health, international relations and so on, each of which comes under some other federal department. The water responsibilities of these departments could not be separated from them into another department without duplicating expertise and risking conflict. Some consolidation has already taken place and there appears to be few additional opportunities. In any event, the diffusion of water-related activities throughout departments with economic, social, and resource management purposes might produce a broader awareness of water issues.

We have also considered the appropriateness of a ministry of state for water or a federal water comptroller, who could set policy objectives and coordinate programs, with other agencies carrying out the programs along with their other specialized activities. However, an office with no operational responsibility of its own would likely be unable to provide the strength and influence needed in this case. Moreover, either of these arrangements would dissipate accountability across departments even more than is now the case. And they ignore the significant federal responsibilities in regulation and research, which other departments could not easily assume.

Having considered these and other alternatives, we have concluded that federal water policy calls for a strong lead agency within Environment Canada. Such an agency would differ from the present agency in its status and authority.

We propose that the Inland Waters Directorate be replaced by a Water Service, comparable to the Atmospheric Environment Service and the other three services in Environment Canada. Like them, the Water Service should be headed by an assistant deputy minister. And it should be explicitly designated as the federal government's lead agency for water policy. Thus, we recommend:

14.1 The Inland Waters Directorate of Environment Canada should be replaced by a Water Service, headed by an assistant deputy minister, and designated as the federal government's lead agency for water policy.

This would have several desirable effects. It would enhance the status of water administration within the federal government, and clarify its responsibility and accountability for water policy. It would also alleviate the administrative anomalies. And finally, since the Minister of Environment would be responsible for coordinating water policy, it would enhance the ability of the central water agency to coordinate water-related programs among other departments.

Function and Administrative Structure

We want to comment further on the internal structure of water administration. Research and experience demonstrate that an organization's structure affects the attitudes, behavior and interaction of those involved in it, and thereby its ability to meet its objectives. The structure must therefore suit the organization's purpose and functions. This implies that how an administrative unit is structured should vary according to the nature of its work in spite of the strong tendency in large, public, unionized bureaucracies to organize uniformly.

The proposed Water Service must serve three different functions. First, it must investigate the condition of water resources through research, data collection and assessment. Such a function is facilitated by a relatively simple, decentralized, informal organization with clear channels of accountability but without a highly structured hierarchy. Second, it must initiate and undertake studies and analyze problems through consultation and negotiation with other agencies. This too calls for a flexible organization. Third, it must ensure that its decisions are acted upon. This requires well structured administrative control. The regional offices are critical in this function.

To respond to this report's recommendations, the new Water Service must be organized differently. Some of the activities currently undertaken by the Environmental Protection Service might need to be transferred to the Water Service so that branches organized around municipal programs, industrial programs, agricultural programs and instream protection would parallel various aspects of the federal-provincial agreements under the National Water Conservation Program we recommend in the following chapter. These branches would need to be served by specialists from divisions in engineering, biology and limnology, economics and social studies, geography and resource development. Project or program teams could be enhanced or diminished as required.

The Environmental Protection Service has a regulatory function and an investigative and planning function. Its regulatory function requires a highly structured organization to ensure consistency, equitable enforcement and accountability. But its investigative and planning and service functions require an interdisciplinary, issue-oriented approach, which is facilitated by a less rigid structure.

We understand that the Environmental Protection Service is currently undergoing internal reorganization. In view of the complaints we have heard about environmental protection legislation being loosely and inconsistently enforced, we consider it particularly important that the service retain the traditional form of line authority for its regulatory functions.

Although the activities of the Environmental Protection Service extend beyond water, it could be organized to assist more effectively in water management. The creation of a toxics and chemicals control branch supported by divisions in strategic planning, chemical engineering, toxicology and research should be explored.

Interdisciplinary Team Work

Water is only one component of the ecosystem; its uses are diverse; and the problems of managing and protecting it require a variety of expertise. Such complex issues can usually be dealt with most effectively by interdisciplinary teams of experts. Members of such teams could be drawn from within Environment Canada, other federal departments, provincial governments and external organizations. Well-organized and well-selected teams can ensure that the best available expertise is brought to bear on issues, information is shared, and the wider implications of decisions are considered. We therefore recommend:

14.2 Environment Canada should develop an interdisciplinary team approach in investigating water management issues and projects.

Environment Canada must put considerable effort into these arrangements. This approach is administratively awkward and needs real authority and accountability.

Teams of this kind have been established to investigate the complicated problems of controlling toxic chemicals and acid rain. Other issues that need a similar approach, such as climatic change, will undoubtedly emerge.

While interdisciplinary teams are suited to investigating issues that call for new management approaches, they should not be terminated as soon as a policy is adopted. They have a role to play for a time at least, in overseeing and advising on implementation.

Policy and Program Coordination

Because the federal government's water-related responsibilities are administered by many departments, to work effectively, each must be aware of the activities of the others. So special attention must be given to coordination, to harmonious institutional relationships and to efficient policy implementation.

Interdepartmental Committee on Water

The Interdepartmental Committee on Water is the main coordinating structure for water matters within the federal government. Formed in 1968, this body was intended to provide a forum for discussion among representatives of the various federal agencies concerned with water. Under its original terms of reference, it was also to recommend for approval all federal water policies and programs, and to report to a committee of ministers, who would resolve any disagreements. But the committee of ministers was never formed and the committee limits itself to exchanging information and dealing with routine matters. It has no policy-making role; conflicts are resolved elsewhere; and projects and programs are seldom referred to it for discussion, let alone approval.

The committee consists of officials from some twenty federal departments and agencies, and is chaired by the assistant deputy minister of the Environmental Conservation Service. Representatives of other units of Environment Canada also attend meetings as members or observers.

The committee establishes permanent and temporary subcommittees, chaired by officials of Environment Canada to deal with particular issues. At present, subcommittees have been set up to consider water quality, flooding, the Great Lakes Agreement, and responses to reports of the International Joint Commission.

Environment Canada staff provide the committee and its subcommittees with secretariat services and publish a quarterly newsletter.

The Interdepartmental Committee on Water is clearly failing to provide the kind of coordination needed to ensure coherent water policy within the federal government. Nor is it serving its intended purposes. It no longer has the power to resolve conflicts among federal agencies nor even to ensure that their positions are coordinated before negotiating agreements with provinces. Its responsibilities and authority are uncertain, and it has lost stature and influence.

Its meetings are becoming less frequent, the level of officials attending meetings has declined, and it is increasingly preoccupied with routine matters rather than policy issues. It is also perceived more as an adjunct to Environment Canada than as an independent policy-making and advisory body. This is undoubtedly due partly to the department's organizational influence on the committee and to its predominating presence at meetings.

To provide the needed coordinating mechanisms, the Interdepartmental Committee on Water needs fundamental changes in its structure, responsibilities and methods of operation — in short, revitalization.

First, Cabinet should confirm the committee's mandate and terms of reference, which should assign to the committee responsibility for reviewing and recommending for approval all significant federal water initiatives and for providing ministers with advice on water policy. Relevant proposals and budgets should be considered by central agencies only after review by the committee. The committee should report through the Minister of the Environment, who should assume responsibility for coordination with other departments.

Second, the committee's membership should be reformed. Members should be senior officials, normally at the level of assistant deputy minister, nominated by deputy ministers and authorized to speak for their departments on policy matters. The number of permanent members should be smaller, consisting of representatives of

Environment Canada, Fisheries and Oceans, Indian Affairs and Northern Development, Agriculture, Transport, Health and Welfare, External Affairs, Regional and Industrial Expansion and Energy, Mines and Resources. Other departments should be invited to send representatives when the committee considers matters relevant to them. Central agencies such as the Privy Council Office, Treasury Board, and the Ministry of State for Science and Technology should be accorded observer status. The committee should be chaired by the assistant deputy minister for the Water Service.

Third, the committee should meet at least quarterly to deal with regular business. In addition, subcommittees should be struck for special tasks. We do not envisage large standing subcommittees, but rather small interdepartmental working groups with a finite life to investigate particular problems or issues. In short, we recommend:

14.3 The federal government should reconstitute the Interdepartmental Committee on Water. The committee should:

- **i) consist of senior officials of federal departments with significant interest in water, and be chaired by the Assistant Deputy Minister of the Water Service;**
- **ii) be responsible for reviewing and recommending for approval all significant federal initiatives relating to water, and for advising ministers on matters of water policy;**
- **iii) report through the Minister of the Environment.**

The chairman of the committee should explicitly be responsible for carrying through the decisions and work of the committee. Environment Canada should provide the committee with an executive secretary and support staff.

Interdepartmental Committee on Toxic Chemicals

Controlling toxic substances presents a particularly difficult coordination problem for the federal government. First, the principal statute for controlling toxic substances, the *Environmental Contaminants Act*, is administered jointly by two departments, National Health and Welfare and Environment Canada. Second, as with so many other environmental problems, provincial cooperation is needed. Third, matters relating to toxic substances are dealt with in some fifty-eight statutes, administered by twenty-four departments, with relevant programs coordinated by eighty formal and informal mechanisms.

In 1984, the Cabinet established the Interdepartmental Committee on Toxic Chemicals to develop general policy, to coordinate toxic chemical activities, and to provide authoritative advice on related policy matters. The committee consists of eleven members and observers and is chaired by the assistant deputy minister of the Environmental Protection Service. It reports to the Minister of Environment. It organizes its activities around priority issues, on a three-year timetable, and assigns responsibilities for developing policy proposals to appropriate departments.

The Interdepartmental Committee on Toxic Chemicals has several features that we consider desirable. It has been established by Cabinet and reports to the Minister of the Environment. Its members are at a senior level. It organizes its policy investigations around issues and works to defined schedules. And, by assigning responsibilities to other departments, it avoids being perceived as an adjunct to Environment Canada.

However, although the committee appears to be suitably structured and organized to carry out its purpose, it has taken some time to establish its terms of reference and the commitment of departments to it appears to be uneven. It will be important to ensure that its membership remains at a senior level.

The problem of toxic chemicals warrants more vigorous attention however. Although this problem is broader than our terms of reference, we think consideration should be given to appointing a senior official to coordinate efforts in this field. Such a federal controller of toxic chemicals could monitor the activities of departments and consultative groups and, by advising the government, ensure that the momentum of effort is maintained.

Interdepartmental Long Range Transport of Air Pollutants Committee

Like toxic chemicals, the problems associated with atmospheric pollution call for a

high degree of coordination. Recently, both federal and provincial governments have formed coordinating bodies. Among these, the most important in the federal government is the Interdepartmental Long Range Transport of Air Pollutants Committee.

This committee is chaired by the assistant deputy minister of the Atmospheric Environment Service. It reviews program plans and activities in an attempt to help coordinate activities among federal departments concerned with long range transport of atmospheric pollution and among interdepartmental public information programs. It also monitors negotiations with the United States and the provinces and attempts to coordinate research and control programs.

The Interdepartmental Long Range Transport of Air Pollutants Committee appears to lack authority and direction (1). Although the Atmospheric Environment Service has implicitly accepted primary responsibility for the committee, it has never been formally acknowledged in this role. No minister appears to have clear responsibility for this committee. Its influence is limited to good will and persuasion and, in the end, each department determines its own priorities. Recently, attempts have been made to strengthen the commitment of other departments and central agencies to the committee. To advance this process, we recommend:

14.4 The Minister of the Environment should be assigned authority for coordinating federal activities relating to the long-range transport of air pollutants. The interdepartmental committee dealing with this problem should be chaired and organized by the assistant deputy minister of the Atmospheric Environment Service, and should report to the Minister.

Without coordinating mechanisms, coherent environmental policy implementation cannot be expected. But we want to stress that it is difficult to make them work effectively. They must be well organized and must receive continuous attention to ensure they remain vigorous and influential.

Before concluding this section, we want to draw attention to the importance of data in facilitating coordination. Reliable, consistent and integrated data systems provide an essential base for collaborative activities. The need to improve data systems and research planning, discussed in Chapter 11, is therefore especially relevant in this context.

Special Problems

Although federal water programs are dispersed among departments and we have found coordination seriously deficient, we did not discover many examples of duplication of effort. However, two cases of awkward working relationships between Environment Canada and other federal agencies were brought to our attention and should be noted here.

In Chapters 2 and 7 we observed that Fisheries and Oceans Canada administers the *Fisheries Act*, though primary responsibility for enforcing the section that deals with controlling water pollution (Section 33) is assigned to the Environmental Protection Service of Environment Canada. A memorandum of agreement assigns administrative responsibility for this controversial section of the Act to Environment Canada, although Fisheries and Oceans Canada retains authority to enforce it as well, if it considers it necessary to do so. We understand that this arrangement was never intended to be a permanent one, but it has remained in effect for many years. It is confusing to outsiders and has caused some strain between the two departments.

The *Fisheries Act* is intended to provide for managing and protecting fisheries, so it should be managed by the department responsible for fish. However, two issues must be dealt with before changes are made. First, Environment Canada must be equipped with adequate antipollution legislation of its own. Second, Fisheries and Oceans Canada must be prepared to perform its fish habitat protection function within the context of integrated watershed management.

We have also detected strain between Environment Canada and the Prairie Farm Rehabilitation Administration in connection with the latter's water-related agricultural activities. In Chapter 10 we propose that irrigation and wetland drainage programs be comprehensively evaluated in the context of integrated watershed management plans. We believe this approach would ensure balanced decision making and forestall conflict. Memoranda of agreement between federal departments have been

effective in clarifying responsibilities in similar cases; such an agreement might be appropriate in this case. We want to emphasize that while the work of the Prairie Farm Rehabilitation Administration extends well beyond water to soil conservation and other activities, we are concerned here only with its water related programs.

Human Resources

Our recommendation in this chapter for improving administrative structures and processes should contribute to a work environment that stimulates performance. Higher visibility for water administration, more focused attention to issues and problem-solving, and improved collaboration with other agencies will create a more challenging and rewarding work environment. However, we have several concerns about the human resources available for water research and management. First, systematic information about Environment Canada's staff is unavailable. The Public Service Commission and the department have routine information on employees, but they do not have consistent information about education, experience, skills and performance, below the level of senior management. This suggests a weakness in personnel management.

Second, the available information indicates that the personnel of particular concern to us here, namely the specialized research scientists and managers, are significantly older and include more who are close to retirement, than other categories. (2) This imbalance has some serious implications for the vigor and creativity of research programs.

The findings of a recent investigation into the future availability of research scientists is relevant here. (3) The report predicts a shortage of scientists with postgraduate qualifications, especially applied scientists and engineers, and specialists in computer science and biotechnology. If these projections are borne out, the combined effects of aging staff and a shortage of replacements may make innovative research programs difficult to maintain.

We are also concerned about provisions for career development among scientists and researchers. In Chapter 11 we suggest arrangements for enhancing their influence, including the appointment of a science advisor to act as their advocate; but to broaden experience and understanding, the department should investigate the opportunities for interchanging personnel among agencies and between the department and universities, nongovernmental organizations and industry. Within the department, exchanges of policy advisors and managers with scientists and researchers could increase understanding. Training programs, study tours and communication networks can also enhance professional capabilities. We therefore recommend:

14.5 Environment Canada should strengthen its policy for human resource planning and development, including arrangements for recruiting, training and retraining to meet projected manpower needs, particularly for research scientists.

Conclusion

Federal water issues cut across departments and jurisdictions. They call for multidisciplinary approaches capable of balancing social, economic and environmental considerations. They also require orderly structures to integrate specialized knowledge and information.

In this chapter we have identified weaknesses in the administrative structures for water policy in the federal government and suggested improvements. But simply reshuffling the organizational chart will not bring about the needed improvements. Clear objectives, leadership, and a capable public service will be needed as well. Structures, processes and people together determine the effectiveness of an organization.

We have not recommended fundamentally new organizational structures. Our pragmatic approach builds on existing institutional arrangements. But we have found a need for substantial improvements in the context within which these institutions operate if they are to respond effectively to the new demands on federal water policy. These are not costly changes, but they require leadership, sensitivity and organizational skill.

Chapter Fifteen

Coordinating with the Provinces and Territories

The time invested in seeking inter-jurisdictional discussion and consensus is well spent.

PROVINCIAL SECRETARIAT FOR RESOURCES DEVELOPMENT GOVERNMENT OF ONTARIO

The federal and provincial governments have all enacted legislation to deal with water-related matters within the scope of their constitutional authority. This legal framework for water management in Canada has been supplemented by a variety of agreements and other arrangements among governments covering a wide range of water matters.

In previous chapters we have documented how federal and provincial responsibilities for water intersect and overlap. Intergovernmental agreements provide a means of reconciling and coordinating joint interests. In this chapter we examine the federal agreements with provinces and territories, and propose improvements in them.

Cooperative Programs

Elsewhere in this report we have described federal programs in which provinces participate. Some of these programs are available to all provinces more-or-less consistently. Others deal with a particular waterway or project or activity and are negotiated separately with the relevant province or territory. In some cases, notably those dealing with interjurisdictional rivers, more than one province or territory are parties to the agreement.

General Programs

Table 15.1 lists the federal programs designed to be undertaken jointly with any or all provinces. Territories sometimes collaborate in these programs as well. The terms and conditions governing participation vary in some cases, but the purpose and working arrangements are generally consistent.

Water monitoring agreements are concerned with collecting data on either water quantity or quality. Since 1975 the federal government — through the auspices of the Water Survey of Canada — has entered into Water Quantity Survey Agreements with all the provinces and with the Department of Indian Affairs and Northern Development for the territories. The agreements allocate responsibility and share the cost of establishing and operating stations for monitoring stream flows, water levels and sediment. They also provide for coordinating committees and information exchange.

A parallel program for water quality monitoring agreements has recently been initiated. An agreement with Quebec has been signed and negotiations with several other provinces are well advanced. As well, all provinces participate in a national inventory of municipal waterworks and wastewater systems.

Federal and provincial governments also cooperate in designing national water quality guidelines for specific purposes such as human consumption and recreation, with the federal government contributing by providing funds and technical expertise. While not a program in the formal sense, it is an important intergovernmental collaborative activity. In 1978 Health and Welfare Canada published the *Guidelines for Canadian Drinking Water Quality* following the research of a federal-provincial working group on drinking water. Similar working groups produced guidelines for *Canadian Recreational Water Quality* in 1983 and a *Report on Municipal Waste Water Disinfection* in 1982.

The Canadian Council of Resource and Environment Ministers has reviewed provincial and federal guidelines for raw potable water, aquatic life, wildlife, irrigation, livestock watering, recreation and industrial water supply; but their work has not yet resulted in any specific or formal agreements.

All of these guidelines relate to matters that are primarily within provincial jurisdiction. They are not legally binding on governments, and the way they are used and modified varies among provinces.

Two programs relate to flood damage (both described in Chapter 10): the Flood

Damage Reduction Program and the Disaster Financial Assistance Arrangements Program. The first identifies flood-risk areas, forecasts floods, constructs control facilities, and commits participating governments to discourage developments in vulnerable areas. It currently involves all except three provinces and Yukon. The second provides aid in response to disasters, including floods. All provinces and territories participate.

The Canadian Heritage Rivers System Program aims to identify Canadian rivers of special heritage value and to ensure their heritage values are protected. So far, six provinces have joined this program.

Environmental accords are intended to rationalize administrative responsibilities for environmental protection, data collection and dealing with the public. Accords have been signed with all of the provinces except British Columbia, Newfoundland and Quebec. No cost sharing is involved. The Canada-Ontario accord was recently extended with the intention of setting objectives for a new, expanded environmental coordination accord.

Special Agreements

Table 15.2 summarizes the special agreements between provinces or territories, and the federal government in 1984/85. These agreements respond to a special problem or issue in one or more province or territory.

The most significant interjurisdictional water management arrangement in Canada is the Master Agreement on Apportionment involving Alberta, Saskatchewan, Manitoba and the federal government. Under it, the provinces agree to share the natural flows of streams flowing eastward from province to province, to cooperate in

Table 15.1
GENERAL INTERGOVERNMENTAL PROGRAMS

Sector	Responsible Federal Department	Participating Provinces and Territories in 1984/85
Monitoring, Surveys and Guidelines		
Water Quantity Survey Agreements Program	Environment	all
Water Quality Monitoring Program	Environment	Quebec
National Inventory of Municipal Waterworks and Wastewater Systems	Environment	all
Water Quality Guidelines	Health & Welfare, Environment	all
Flood Damage		
Flood Damage Reduction Programs	Environment	all except Prince Edward Island, British Columbia, Alberta, Yukon
Disaster Financial Assistance Arrangements Program	Emergency Planning	all
Others		
Canadian Heritage Rivers System	Environment	all except Prince Edward Island, Quebec, Alberta, British Columbia
Accords for the Protection and Enhancement of Environmental Quality	Environment	all except, Quebec Newfoundland, British Columbia

Source: Adapted from Government of Canada, Federal-Provincial Relations Office. 1984. *Federal-Provincial Programs and Activities 1983-1984*. Supply and Services Canada. Ottawa. Updated to January, 1985.

effecting the most economical and beneficial use of interprovincial waters, and to refer disputes to the Federal Court. The agreement is administered by the Prairie Provinces Water Board.

Other agreements serve to regulate waters in the Ottawa River, Lake of the Woods and the Qu'Appelle. Special flood damage control agreements have been entered into with British Columbia and Manitoba.

Several agreements have been signed with provinces and territories for conducting river basin studies or investigating pollution problems in particular waterways. The report of the Yukon River basin planning study, undertaken with British Columbia and Yukon, is soon to be released. A planning study of the Fraser River estuary was produced in 1982 under an agreement with British Columbia, and an implementation strategy is now being reviewed. Other studies recently completed include a preplanning study of the Winter River in Prince Edward Island and a planning study relating to mercury pollution in the English and Wabigoon River system in northwestern Ontario.

The federal government has also entered into arrangements with Manitoba on mercury pollution associated with the Churchill River Diversion; with Ontario on water quality in the Great Lakes; and with Ontario and Quebec on water quality in the Ottawa River.

Several agreements with prairie provinces deal mainly with water development for agriculture. Agreements relating to transportation and navigation include special harbour improvement agreements with British Columbia and Ontario, and agreements concerning the St. Lawrence Seaway with Ontario and Quebec. Water supply and wastewater works are being developed under agreements with Saskatchewan and Ontario.

Two special agreements deal with hydroelectric development. One, with Nova Scotia, concerns a low-head hydroelectricity demonstration project. The other, with Newfoundland, deals with development of the lower Churchill River.

Other arrangements

The agreements summarized in Table 15.2 include only those dealing *primarily* with water matters. A considerable variety of other federal-provincial agreements affect water management incidentally. Particularly relevant in this context are the federal government's Economic and Regional Development Agreements.

Such agreements have recently been negotiated to replace the General Development Agreements that expired in 1984. They are ten-year umbrella agreements that provide for subsidiary agreements, memoranda of understanding and coordinating mechanisms. The subsidiary agreements listed in Table 15.2 include agriculture-related programs and a water supply project.

Other agreements that affect water management incidentally bear on planning and pollution control. The subsidiary agreement dealing with development of the pulp and paper industry in Newfoundland and the agreement for new and improved numicipal infrastructure in Quebec are examples.

Table 15.2 also excludes informal working arrangements between the federal and provincial governments, which are numerous and varied. Particularly notable is the consultation and cooperation in river systems studies or projects. Examples include planning for the Waterford and Winter rivers, assessing the potential impacts of the Slave River hydroelectric project, and water quality monitoring related to the Garrison Diversion project.

Two other types of informal cooperation are important to water management. One is the cooperation between the Prairie Farm Rehabilitation Administration and agencies of the prairie provinces in planning and carrying out irrigation and other water projects, such as the Southwest Saskatchewan Irrigation Projects, the Irrigation Demonstration farm in Outlook, Saskatchewan, and dyking projects on the Assiniboine River. The other is the referral process through which fish habitat protection officials of the Fisheries and Oceans Canada routinely review development proposals that some provincial and territorial governments refer to it.

Consultative Mechanisms

Certain mechanisms exist for continuing intergovernmental consultation and collaboration on water-related policies. We turn to these now.

The Canadian Council of Resource and Environment Ministers

The Canadian Council of Resource and

Table 15.2
SPECIAL INTERGOVERNMENTAL AGREEMENTS

Sector	Responsible Federal Department	Participating Provinces and Territories in 1984/85
Regulation and Apportionment		
Prairie Provinces Water Apportionment Agreement	Environment, Agriculture	Alberta, Manitoba Saskatchewan
Ottawa River Regulation Planning Board	Environment	Ontario, Quebec
Lake of the Woods Control Board	Environment	Manitoba, Ontario
Qu'Appelle Conveyance	Environment	Saskatchewan
Flood Control		
Lower Fraser Valley Flood Control Implementation	Environment	British Columbia
Manitoba Northern Flood Agreement	Indian Affairs and Northern Development	Manitoba
River Basin Arrangements		
Yukon River Basin Study	Environment, Indian Affairs and Northern Development	British Columbia, Yukon
Fraser Estuary Planning	Environment	British Columbia
Mercury in the Churchill River Diversion System[a]	Environment	Manitoba
Canada — Ontario Agreement Respecting Great Lakes Water Quality	Environment	Ontario
Ottawa River Water Quality Coordination	Environment	Ontario, Quebec
Mackenzie River Basin Committee	Transport, Environment, Indian Affairs and Northern Development	Alberta, British Columbia, Saskatchewan, Yukon, Northwest Territories

Agriculture		
ERDA Subsidiary Agreement on Agricultural Development	Agriculture, (Prairie Farm Rehabilitation Administration)	Saskatchewan
ERDA Subsidiary Agreement on Agri-Food	Agriculture	Manitoba, New Brunswick, Prince Edward Island
ERDA Subsidiary Agreement on Agricultural Community Water Infrastructure	Agriculture, (Prairie Farm Rehabilitation Administration)	Saskatchewan
Alberta Irrigation Rehabilitation Agreement	Agriculture, (Prairie Farm Rehabilitation Administration)	Alberta
South Saskatchewan River Project Agreement	Agriculture, (Prairie Farm Rehabilitation Administration)	Saskatchewan
Transportation		
Financial Assistance for Harbour Improvement*	Transport	British Columbia, Ontario
St. Lawrence Seaway Agreements*	St. Lawrence Seaway Authority	Ontario, Quebec
Waterworks		
ERDA Subsidiary Agreement on Regina-Moose Jaw Water Supply	Environment	Saskatchewan
Special Recovery Capital Projects	Environment	Ontario
Hydro Power Development		
Low Head Hydroelectricity Demonstration Project	Energy, Mines and Resources	Nova Scotia
Lower Churchill Development Corporation	Energy, Mines and Resources	Newfoundland

Note:
* Agreement(s) still valid but no federal funds were allocated in recent years.

Source: Adapted from Government of Canada, Federal-Provincial Relations Office. 1984. *Federal-Provincial Programs and Activities 1983-1984*. Supply and Services Canada. Ottawa. Updated to January, 1985.

Environment Ministers, coordinates water and other environmental policies. It consists of the federal Minister of the Environment and the minister from each provincial government that has primary responsibility for environmental and natural resource matters. It serves as a forum for exchanging information, coordinating policies and facilitating cooperation between federal and provincial governments. It searches for consensus on matters of mutual interest, but its conclusions and decisions are not binding on member governments.

The Council of Ministers has a rotating chairman and a five-member executive, as does its coordinating committee of deputy ministers. Council meetings are held at least annually in the capital city of the current chairman. Each of the eleven governments contributes to the council's budget, currently about $330 thousand, with the federal government contributing about one-third. This is sufficient to support a small secretariat with offices in Toronto.

Most of the council's work is carried out by committees or working groups set up to examine specific topics. Recent topics have included acid rain, toxic substances and water quality objectives and guidelines. A research and monitoring coordinating committee, cost-shared by eastern provinces and the federal government, was established several years ago to focus on acid rain. A parallel consultative committee for western Canada has also been established.

The interests of the Canadian Council of Resource and Environment Ministers extends beyond water to other environmental and resources management issues. However, with respect to water matters, it does not appear to have taken sufficient advantage of its opportunity to harmonize policies and resolve the jurisdictional problems we have identified in this report. It has tended to address problems only when they have become critical and to proceed slowly. Perhaps because it meets infrequently and has a meagre secretariat, and operates by consensus, it appears to serve as a forum for discussion more than a mechanism for collaborative action. Nevertheless, its structure is appropriate for political consultation and the coordination of water policies and programs of federal and provincial governments.

The Prairie Provinces Water Board

The Prairie Provinces Water Board administers the apportionment agreement for prairie rivers. The board maintains offices and a small staff in Regina and meets biannually. Its chairman is the senior federal representative and its members are officials of the governments of Alberta, Saskatchewan and Manitoba and the Prairie Farm Rehabilitation Administration.

The apportionment agreement is the only formal intergovernmental water apportionment agreement in Canada. Its major provision commits Alberta to allowing one-half of the natural water flow arising in or flowing through Alberta to pass into Saskatchewan. Saskatchewan has a similar commitment to Manitoba. The potential scope of this agreement is considerable because it can affect decisions about water diversions and consumption uses.

The Prairie Provinces Water Board succeeded in implementing the apportionment agreement without serious conflict or dispute. And it provided a forum for consultation among the governments involved on water management generally. But, as we pointed out in Chapter 7, the agreement is fragile since any of the parties could unilaterally pass legislation that would exempt it. Moreover, the board makes decisions only when all parties concur. As a result, it has been slow to address sensitive but important problems such as water quality in interprovincial rivers.

Our recommendations in Chapter 7 will strengthen structures such as the Prairie Provinces Water Board by providing orderly procedures and ultimate authority for resolving interjurisdictional disputes.

Other Arrangements

Consultative committees were established between Environment Canada and most provinces following the *Canada Water Act*'s enactment in 1970. Comprised of senior public servants, these committees were expected to review priority needs and government objectives and to identify basins or issues that could become the subjects of cooperative undertakings. Most of these committees met infrequently, if at all, and are now dormant. Their intended functions have been assumed by other federal-provincial bodies that have more focused responsibilities. Among these are the numerous federal-provincial boards and committees involved in specific water management activities, such as the Prairie Provinces Water Board, the Mackenzie River

Basin Committee, the Fraser River Board, the Flood Damage Reduction Steering Committees, and other shorter-term basin planning and implementation committees. However, a more deliberate and long-range consultative mechanism is required.

Toward Improved Intergovernmental Coordination

Our review of constitutional responsibilities in Chapter 6 reveals that the federal and provincial roles in water management are closely intertwined. The provinces' broad mandate for managing water uses is overlaid with federal responsibilities in fisheries, navigation, agriculture, interjurisdictional waters and so on, which inevitably impinge on provincial management programs. In the northern territories the process of transferring responsibilities for resource management to the territorial governments raises special, but related, problems. Accordingly, in the interests of efficient water management, the federal government must reconcile and harmonize its programs with provincial and territorial governments.

Federal and provincial governments each have constitutional responsibilities which constrain the activities of the other. But within these constraints, efficient and effective resource management calls for policy and program coordination. This, in turn, requires that federal and provincial governments inform one another about their policy objectives and means of pursuing them, exchange data and other information of mutual interest, design their programs to complement rather than conflict with each other, and cooperate in activities in which both have an interest. In the remainder of this chapter we discuss mechanisms for facilitating this coordination.

The federal government's approach to coordinating its water-related policies with those of provincial governments should be designed to do the following:

- Contribute to the federal role in water management. In the preceding chapter we described our interpretation of the appropriate federal role in water management, in providing leadership, in protecting the national interest, in resource development and environmental protection, in managing uses over which it has jurisdiction, and in enhancing scientific knowledge and expertise.
- Contribute to provincial objectives. Coordination involves reciprocal commitment and effort, so it must be mutually advantageous.
- Enhance efficiency. This entails taking advantage of opportunities to standardize procedures; to exploit economies of scale; and to avoid duplicated efforts through pooling information and management and research capabilities.
- Promote consistency in federal programs. Coordinated federal, provincial and territorial efforts can help to ensure that federal programs will be implemented equitably and consistently throughout Canada.

Accomplishing these goals will require two mechnisms: a forum for consultation and negotiation among the governments involved and an administrative instrument for defining joint undertakings. We turn to the latter first.

A National Water Conservation Program

We have identified a variety of federal activities so closely related to provincial interests that they should be undertaken only with provincial cooperation and participation. Hydrometric surveys, design of water quality guidelines, and flood control are only some of the activities in this category. The federal government should neither undertake these programs unilaterally nor impose them on the provinces; rather, it should encourage the provinces to join in cooperative programs.

We propose a National Water Conservation Program to provide a framework for these cooperative efforts. This program is intended to encourage individual provinces to participate with the federal government in a variety of joint programs and activities. The intent is to harmonize policies, clarify working responsibilities and avoid duplication of effort, inefficiencies and conflict. If this can be done, it will assure Canadians that their governments are collectively committed to a high standard of water resource management.

Program Structure. Under the proposed National Water Conservation Program, the federal government would stand ready to enter into agreements with provinces on specified activities on a consistent, cost-sharing basis. Individual provinces would be free to participate in any or all of these activities. The agreements would

enable the federal government to provide leadership in directing attention and resources to urgent problems and to implement the approaches to water resource management we proposed in this report.

To put this program into effect, we suggest that the federal government enter into master agreements with the provinces on water conservation and development. These agreements should set out a general commitment on the part of both governments to cooperate. They should be similar for all provinces and should be designed in consultation with them collectively.

These master agreements (like the Economic and Regional Development Agreements) should also provide for supplementary or subsidiary agreements covering specific programs and other cooperative arrangements. Individual provinces should be free to join in any or all of these joint programs.

This structure provides for the essential consistency of federal policy while allowing for flexibility of participation on the part of the provinces. Several agreements on specific programs like flood control, data collection, planning and so on already exist. The structure suggested here would allow these supplementary components to be incorporated flexibly; but wherever they are incorporated, the federal role would be consistent. We therefore recommend:

15.1 The federal government should invite the provincial and territorial governments to collaborate in a National Water Conservation Program. This program should be embodied in general water conservation and development agreements between the federal and the provincial and territorial governments. These master agreements should:

- **i) be designed in consultation with the provinces and territories;**
- **ii) include a general commitment to cooperation in water matters and set out the principles and conditions of cooperation;**
- **iii) provide for supplementary agreements on specific collaborative programs;**
- **iv) specify consultative arrangements to oversee joint undertakings.**

In Chapter 10 and elsewhere, we identified a variety of programs that should be covered by supplementary agreements. These include water surveys and monitoring, regulation and apportionment agreements, flood damage programs, river basin studies, the heritage river program, municipal infrastructure development, water-related agricultural programs and water pollution control programs. Other arrangements may be suitable for inclusion as well.

To avoid the deficiencies of similar agreements in the past, the supplementary agreements should satisfy several conditions: they should commit both governments to a definite term, so orderly plans can be made and activities completed; they should, where appropriate, deal explicitly with responsibilities for capital works and for continuing operational and maintenance costs; they should specify the administrative arrangements to be adopted; and they should provide for continuing consultation between the two parties regarding program execution.

To ensure a consistent approach, agreements on specific programs should be entered into *only* under the auspices of a master water conservation and development agreement. Provisions will be needed to accommodate the expiry and renewal of existing agreements.

Design procedure. To realize the full potential of the proposed National Water Conservation Program all governments must subscribe to it. Therefore, they should all be involved in its design. This calls for political guidance. The Canadian Council of Resource and Environment Ministers appears well structured for this purpose; thus, we recommend:

15.2 The federal Minister of the Environment should invite the Canadian Council of Resource and Environment Ministers to assist in designing the National Water Conservation Program.

For this purpose, the Council may find it advantageous to appoint a special committee to expedite negotiations and take advantage of the expertise and advice of other knowledgeable Canadians. In any event, it should give careful attention to the following:

- The need to design particular programs

so they can accommodate the different provincial and territorial circumstances, while ensuring a consistent federal role and financial contribution.
- The need for provinces and territories to be able to select among the available joint programs while maintaining equitable opportunities to participate.
- The need to divide responsibilities between governments, so they are clear and understandable not only to public servants but also to the public.
- The desirability of minimizing overlapping administrative effort by delegating administrative authority where practicable.

Funding. Initially, as existing programs are rolled over into these new arrangements, the need for additional funds may be small. But, if the program succeeds and gathers momentum, as we hope it will, the financial requirements will grow.

Because we are dealing with joint programs in which the participating governments have a mutual interest, the burden should be shared. A government's contribution need not be financial for all programs; for some, personnel or other services may be most appropriate.

In any event, we have proposed in Chapter 10 and elsewhere that those who use water and its waste disposal capacity should pay for the benefits they receive. Suitably designed user charges, can not only provide incentives to conserve water and protect its quality, they can also provide considerable revenue. For example, we estimate that each cent per thousand litres levied on current withdrawals in Canada (excluding hydroelectric uses) would yield some $500 million annually. Even allowing for some reduction in use in response to pricing, the revenue would be considerable. These and other possibilities for raising revenue, should be considered. We consider it unnecessary and undesirable to continue to rely on the already strained general revenues of governments to meet the costs of expanded water programs.

Intergovernmental Communication and Consultation

The collaborative arrangements we have discussed in this chapter call for consultative mechanisms to design programs, negotiate agreements and oversee their implementation. We have already suggested that the Canadian Council of Resource and Environment Ministers should assist in designing the proposed National Water Conservation Program. But since the program is not intended to be static, the Council should also watch over its development. Because the program will determine interactions among governments, it will need continuing political guidance.

A consultative mechanism will also be needed to negotiate and oversee each agreement's implementation. To meet this need we recommend:

15.3 The federal government and each provincial and territorial government should establish a joint management committee to negotiate and supervise the implementation of their water conservation and development agreements.

These committees should consist of senior officials of the two governments, who are capable of articulating their governments' policies and resolving disputes. They should therefore include the deputy ministers responsible for water matters or their delegates (acting alternately as chairman) and representatives of other appropriate departments. The committee should report directly to the two ministers. The water conservation and development agreements should provide for these committees.

Finally, a federal official in each province and territory will be needed to coordinate federal water programs and activities and to serve as a point of contact on federal water-related programs. This official would be responsible for providing information about federal water programs and policies, liaising with the provincial or territorial government and other federal agencies, and exercising continuing surveillance over joint activities. Accordingly, we recommend:

15.4 The federal government should designate an official in each province and territory to coordinate and provide information about federal water policies and programs.

This official could be the regional director of the water service or the federal economic development coordinator.

Elsewhere in this report we propose improved arrangements for disseminating information and stimulating public awareness about water resources and their man-

agement. These improvements, along with a federal water coordinator in each jurisdiction, should alleviate much of the prevailing confusion about federal water policy and administration.

Conclusion

We have found intergovernmental coordination seriously inadequate to cope with the complicated interdependence of federal and provincial responsibilities in water matters. The resulting impediments to information exchange, duplicated effort and inefficiency are undoubtedly considerable.

In this chapter we have tried to build on existing structures and programs to create a framework for more effective water management in Canada. Our proposal for a National Water Conservation Program is an invitation to governments to manage water in a coordinated, shared way in which beneficiaries will pay for benefits they receive. Canadians concerned about water resources clearly want closer coordination among governments, and governments themselves have much to gain from collaboration. However, making improvements of the kind we propose will be difficult and will call for much goodwill and determination.

Chapter Sbeen

Channelling Public Participation and Advice

. . . information is essential in allowing people the full exercise of their rights to participate in the formulation of public policy.

FRIENDS OF THE EARTH

In preceding chapters we have made a number of recommendations aimed at improving decision making about water. In this chapter we examine the role the public should play in the decision-making process. A well-informed public and clearly defined structures to channel their participation provide the best assurance that management decisions will take into account the full spectrum of public values. This, in turn, contributes to more acceptable and effective resource management. Equally important is the value of information and understanding in motivating citizens to accept personal responsibility for the way they use water resources.

Provisions for public participation in water management are particularly important because decisions about how water is used have broad implications. This is evidenced by the numerous environmental and recreational organizations, native groups, agricultural and industrial associations and professional bodies who take a keen interest in water management.

Information and Education

Members of the public need reliable information about our resources and management problems to appreciate the value of water and to make judgements about water management. Only with an awareness of the pressures we impose on our water resources will Canadians understand and support needed policy changes.

But providing more public information will not in itself ensure wise management. We also need to improve the understanding we have about natural resources in order to change attitudes and behaviour, a need that will increase in the future as the challenge of water management becomes more complex. Unless we understand the full consequences of our actions and the possible means of modifying them, we are likely to waste precious resources.

Environment Canada has a statutory mandate to provide Canadians with information about their natural environment, so this department must assume the federal government's responsibility for stimulating public awareness and understanding of water. It should make research findings and up-to-date information about environmental hazards widely available in a form understandable to the nonscientist. Information can be disseminated in many ways: newsletters, statistical publications and journals, teaching aids, media advertisements and conferences.

Current efforts

We have been unable to quantify the federal resources devoted to education and public information about water, but they are substantial. Fisheries and Oceans, Agriculture, Parks Canada, the Canadian Wildlife Service, the International Joint Commission and others all provide some public information. Environment Canada alone expends an estimated $6 million annually on public information and related programs from its total budget of more than $800 million. Much of this is expended by Parks Canada. (1)

The corporate information group of Environment Canada publishes bimonthly *Environment Update*, which highlights specific issues and includes articles on topics that reflect the full spectrum of Environment Canada's services. The group also issues press releases and special publications on issues like acid rain.

Each service within Environment Canada provides audio visual material, brochures and displays for expositions. Although the department has cooperated with Vista, TV Ontario and the CBC on occasion, it has not made extensive use of television and film.

The Inland Waters Directorate has produced an information kit on flood damage reduction and a series of pamphlets in response to public requests about water treatment. It also publishes biannually the *Canada Water Year Book*. The first of these provided broad general coverage of Canada's water resources; subsequent editions have featured particular topics such as water management, research and data. The directorate also prepares a considerable amount of scientific and technical information, but does not distribute it widely.

Demonstration projects are particularly effective educational tools. One example is a current federal-provincial agricultural project in Ontario demonstrating the benefits and costs of soil and run-off conservation in controlling pollution.

Although the federal resources directed to public information and education about water are considerable, no systematic attempt has been made to evaluate their effectiveness. We consider such an assessment essential in developing new approaches, and so recommend:

16.1 Environment Canada should undertake a thorough evaluation of its efforts in public information and education.

We suggest this evaluation be undertaken externally. It should take into account the programs and activities of other federal departments and agencies, other government and private organizations, and the views of the public. And it should be directed to draw conclusions and make recommendations regarding specific objectives for Environment Canada.

New approaches

We see a need for the federal government to improve public awareness and understanding about water resources and management problems in Canada through a stronger, more concentrated effort. But this effort should not be launched in isolation; the government should encourage others to join in since much of the capacity to execute such programs lies outside the federal government. Responsibility for education lies with the provinces; and public schools, technical institutes, colleges and universities are undoubtedly capable of playing a significant role. A recent school program in Calgary illustrates the potential. (2) Environmental and sporting associations, and industrial and labour organizations also afford channels of communication with large numbers of interested Canadians. And, of course, the media serve a special function in informing the public and in shaping public attitudes.

Given these resources, we believe the federal government should play a catalytic role, initiating and supporting the efforts of others. The PARTICIPAction program, aimed at creating and sustaining public sensitivity about fitness and health, could serve as a model. It took a national program that had been nibbled at by government agencies over the years and made it a success.

PARTICIPAction was led by a prestigious board of directors who accepted only "seed money" from the government and sought needed funds from private sources. It did not involve itself directly in operational programs but by using modern marketing techniques, helped promote those programs already concerned with fitness. With a small staff, PARTICIPAction generated considerable media attention, attracted corporate support, stimulated economic activity and catalyzed community activities. Many Canadians soon became aware of the great PARTICIPAction Challenge and Walk Around The Block.

We believe a similar approach could be used to interest Canadians in water conservation and development. We therefore recommend:

16.2 Environment Canada should initiate and support a national water conservation awareness program, similar in organization and approach to the PARTICIPAction program.

This implies appointing a strong, independent board to direct the program and providing it with sufficient financial support to begin its activities. Additional funding should be sought from the private sector and the provincial governments should be asked to participate.

Public Participation in Water Management

In recent years, governments have increasingly sought the views of special interest groups and the public at large before making decisions, especially when they involve natural resources and environmental mat-

ters. This reflects, among other things, a growing anxiety about the way we have traditionally used our natural resources, deep concerns about the environment's widespread degradation, citizens' feeling alienated from their governments, and frustration with the ability of traditional political structures to register public opinion about particular issues and decisions. Improved education, higher public aspirations and the expanding governmental role have also contributed to the demand for greater public participation.

Canadians are becoming increasingly wary of relying on governments and private business interests to safeguard the environment and to manage natural resources. This is reflected in the number and variety of voluntary organizations that focus particular interests and thus influence decisions ranging from local projects to national policies. Some view public participation in decision making as a right and a serious responsibility.

The potential contribution of public involvement

Undoubtedly, well-channeled public participation can improve decision making: it can make decision makers aware of the variety and strength of public attitudes; it can provide a wealth of expert advice, local knowledge and information that would otherwise be unavailable; and it can expose alternatives that might otherwise go unnoticed.

Moreover, public involvement helps disseminate information, which reduces misapprehensions, polarization and conflict. Open debate improves mutual understanding, promotes the search for compromise, and enhances the credibility and acceptance of the ultimate decision.

However, the process has some limitations: generating and channelling advice can be arduous and costly for participants and government. The process therefore requires careful planning and orderly procedures. And the procedures must somehow recognize the disparities among interest groups in financial resources, technical expertise and power. In addition, governments must recognize that individuals generally participate only when they see their interests directly affected. So when a project's or decision's impact is widely diffused, it is likely to generate less reaction than when it is focused, even though its total effects may be substantial.

A successful public participation program must contain several critical elements. First, it must be credible: it must not only influence ultimate decisions but be perceived to do so. Otherwise, it will simply generate cynicism. Credibility requires visible processes for generating public input and for communicating that input to decision makers. Moreover, communication must flow both ways, between the participants and the government.

Second, to be constructive, participants must have access to reliable information and expert guidance. Without these, speculation and arguments about data will undermine informed discussion.

Third, consultations must begin early enough to influence the initial design of a project or program. And the dialogue must continue between planners and the public throughout implementation and evaluation. For construction projects, this implies consultation through the post construction audit phase.

Fourth, the process must be open and fair to all who want to participate. In particular, it must recognize the legitimate interest of those who are not members of well-organized groups, and so must canvass the views of the public at large as well as segments of it.

Finally, the public must not see public consultation as serving as a substitute for decision making, but rather as contributing to it. The impression that consultations are used to avoid or postpone decisions is as destructive as the perception that the decision has already been made. In short, public consultation puts a heavy onus on governments to respond.

Public consultations

Public participation in water resource management has evolved over the last forty years. In the 1940s, Ontario's conservation authorities channeled grass-roots interests in flooding and soil erosion problems. Public attitudes about hazards, such as floods, have been studied since the 1950s.

But the demand for public participation emerged with unprecedented force in the 1960s in a political climate that was receptive to innovations. Public participation penetrated throughout public affairs, including water management. Thus, the

1970 *Canada Water Act* authorized the federal minister to enter into agreements with provincial governments for the purpose of formulating comprehensive water resource management plans "taking into account views expressed at public hearings and otherwise by persons likely to be affected by implementation of the plans." This provision ensured public involvement in various river basin studies such as those of the Okanagan, Souris, St.John and Shubenacadie-Stewiacke watersheds.

The 1970 *Northern Inland Waters Act* provides for public participation in a range of water resource matters. And, as we pointed out in Chapter 13, this act makes public hearings on water licensing mandatory in Yukon and the Northwest Territories.

Elsewhere in this report, we have recommended other provisions for public participation in water resource management decisions. We suggested that public hearings should be convened on all major project proposals and that watershed management advisory committees be established in appropriate circumstances.

In 1980, Environment Canada adopted a Public Consultation and Information Availability Policy. The policy consists of four parts:

- Public consultation, which assures a regular opportunity for the public to meet with department officials to discuss environmental issues and concerns;
- Regulation making, which requires all significant new regulations and guidelines to be made available for public comment at all stages of their formulation;
- Information availability, which makes most departmental information accessible to the public; and
- Contributions to transportation expenses, which helps qualifying groups to attend designated meetings. (3)

The commentary we have received on this policy has been mixed. While some commentators applaud the department's annual, regional consultations, others find them too loosely organized and discussion too broad to provide useful public input on any particular question. These meetings, convened annually in each of the regions, provide forums for public discussion of all the department's environmental programs, not just those concerned with water. The department recognizes that the consultations meet with varying degrees of success, but remains committed to the process as a way of sensitizing itself regularly to public views.

Environment Canada is one of the few federal departments that provides such a medium for public commentary. We support this effort in principle, but because experience with it has been brief, we have found it difficult to evaluate. Nonetheless, it appears that these consultations would benefit from more focused agendas and advance preparations. We advise the government to continue this experiment for now; in another three years, it should be thoroughly reviewed in consultation with those who have participated prominently in it.

Expert consultations

Within the past year, Environment Canada set up several expert consultations involving provincial, industrial and labour leaders, academics and representatives of environmental groups in an attempt to find a consensus on ways to reduce water and air pollution at source.

One of these, the task force convened by the Niagara Institute on behalf of Environment Canada, is investigating methods of controlling toxic wastes. Others are concerned with data systems, with a report on the state of the environment and with developing arrangements for industry, labour and government to collaborate on environmental problems.

It is too soon to assess these efforts, but the attempt to focus the collective expertise of scientists, public administrators, industry and labour representatives and environmentalists on practical solutions to pollution deserves encouragement.

The department also conducts consultations with experts as required, as on flood damage reduction programs, and with industry associations.

Environmental assessment of projects

While not designed specifically for water development projects, the Environmental Assessment and Review Process must be recognized here. It ensures that, early in the planning stage before irrevocable decisions are made, all federal government departments consider fully the environmental and social implications of proposals for large projects involving federal funds or responsibilities. When potential implications are

significant, the proposals are referred to the Minister of the Environment for public review. A panel appointed specifically for each project holds public hearings in communities near the site of the proposed undertaking and prepares a report for the Minister. It may recommend that a project be abandoned, postponed or, more often, modified.

This process has some limitations: it does not necessarily consider rigorously all economic and social issues, departments do not always use the process and, of course, its decision are not binding. We do not consider this process appropriate for projects involving international transfers of water, so in Chapter 12 we have recommended a special review procedure for that purpose.

Advisory Councils

Standing advisory committees or councils are potentially one of the most effective ways of bringing external advice to bear on federal policy making. With well-informed membership, clearly defined terms of reference, adequate resources and receptiveness on the part of governments, they can provide valuable and influential guidance.

The Canadian Environmental Advisory Council was established in 1972 to advise the Minister on the state of the environment, environmental threats and priorities for federal or intergovernmental action. In addition, it was to appraise Environment Canada's effectiveness in protecting the environment. The sixteen council members, who serve as individuals, are drawn from scientific, commercial and educational communities. Officials of Environment Canada do not serve on the council, but the department provides a secretariat. In 1983-84 the council was supported with a budget of about $200 thousand and a staff of two.

The council has undertaken studies on matters as diverse as pest control, wildlife conservation and agricultural soils. It has assessed Environment Canada's policies on public consultation and its role in the north. And it produces two or three publications per year. Its latest report indicates that it has prepared commentaries for the Minister on issues as general as the relationship between the environment and the economy and as specific as the proposed Ellesmere Island National Park. (4)

The council admits to giving priority to providing private and confidential advice to the Minister. For obvious reasons, we cannot evaluate the council's effectiveness in its confidential advisory role.

However, the council has clearly failed to develop significant public recognition. Its existence and publications are virtually unknown to the general public; it has not taken positions in public forums; and it has left public education on environmental matters to others.

We question the appropriateness of this mode of operation. As we have already suggested, environmental decision making is best served when information and advice flow both ways, to the ultimate decision makers and to those affected by the decision.

We question also the adequacy of the council's terms of reference, which are somewhat vague and have been modified over the years without clear purpose. As a result, each minister has used the council differently and in varying degrees. While some flexibility is desirable, a well-defined purpose and clear direction for action would enable the council to make a much more significant and measurable contribution to federal policy making.

While the scope of the council's concern extends beyond water resource management, we believe its structure and functions should be changed. It should study and report on matters of environmental policy. Like the Economic Council of Canada and Science Council Canada, it should be provided for by statute and report to Parliament. This would ensure that environmental issues are kept before the government and enable the public to benefit from its investigations and advice.

We also suggest that such a strengthened council be responsible for publishing every five years a report on the state of the environment, as the Economic Council of Canada reports on the condition and trends in the national economy. Canadians and their government need to be advised regularly about the health of the natural environment, and this would be an appropriate function of the council. The council should also publish reports on its special studies and annual reports on its activities.

We therefore recommend:

16.3 The Canadian Environmental Advisory Council should be replaced by a new, independent council devoted to investigating issues of environmental policy.

This new council should:

i) **consist of members who have high stature and wide knowledge of environmental matters;**
ii) **prepare a comprehensive report every five years on the state of the natural environment in Canada;**
iii) **investigate and report, with recommendations, on such environmental problems in Canada as it considers appropriate or as may be referred to it, as well as publish an annual report on its activities;**
iv) **report to the Parliament of Canada.**

The council should be given a new name and specific terms of reference to guide its activities. It should be allocated sufficient resources to maintain professional staff and to carry out its work independently and effectively.

The proposed periodic report on the state of the environment raises the issue of environmental data. At present, the methods used to compile and analyze data vary among jurisdictions and agencies. Improved coordination in data collection, interpretation and dissemination would produce considerably more useful information to resource users, researchers and other interest groups as well as the new environmental council.

This sensitive problem has been examined through the expert consultations described above, and a task force convened by the Niagara Institute provides a promising forum for identifying opportunities for coordination among governments, nongovernmental organizations and industry. They have also drawn to our attention, the costs involved in acquiring data needed for this purpose. However, policy changes in the various jurisdictions will likely be needed to implement such arrangements. Proposals might be referred to the Canadian Council of Resource and Environment Ministers for consideration and action.

Conclusion

In concluding this chapter, we want to reiterate the importance — indeed the necessity — of providing orderly channels of communication between the public and governments on environmental matters. Our hearings have provided clear evidence of the demand for information and for public participation in decisions about the way our resources are managed. Moreover, we are confident that open consultations will improve decisions, broaden their acceptance and generate public support for needed policy changes.

Part VII

Overview

Chapter Seventeen
Strategies for Reform

Like freedom, water must not be squandered or be allowed to slip away from us in dribs and drabs. Hence, a strong statement and policy with strict laws to protect this resource and an effort to raise the understanding of people will lead to maintaining this increasingly valuable resource.

FISHERIES COUNCIL OF BRITISH COLUMBIA

This report has documented some general observations we made in the introductory chapter about water and water management in Canada. We observed that Canadians are blessed with extraordinarily abundant water resources, which have had a profound influence on our economic and social development. We also observed that this abundance has tended to make us complacent about our water resources as reflected in the meagre effort we have made to learn about and protect them, and in the often casual and fragmented policies we have adopted for managing them.

We noted as well that attitudes towards water are changing. Increasing pressures on available supplies, conflicting demands and new threats to water quality are converging to make Canadians aware that they can no longer take plentiful supplies of clean water for granted. And many fear that our present water policies are inadequate to cope with the emerging pressures on our water resources.

Such anxieties have produced a mood for change. It is therefore timely to reassess our approach to water management in Canada.

Currents of Change

We devoted an early chapter to the evolution of federal water policy to show how historical circumstances had produced the present array of federal water programs and organizational arrangements. We also wanted to emphasize the dynamic nature of water policy by tracing its responses over the decades to changing economic and social needs, technological developments, political evolution and public aspirations.

During the last few years the pace of change has quickened. The rapid industrialization and urbanization of Canada during and following World War II put heavy demands on water resources in regions of concentrated development, and introduced us to large-scale pollution. These new management problems along with the heightened public awareness that accompanied the environmental movement of the 1960s resulted in significant shifts in water policy. The traditional emphasis on using water resources to promote economic growth shifted to protecting water systems from the pressures of an industrial economy. The success of environmental protection policies has been mixed, but new problems like toxic substances and acid rain continue to challenge policy-makers.

As environmental protection policies were introduced, they were often perceived as conflicting with economic growth. Pollution was considered an inevitable consequence of industrial expansion; jobs were at stake if regulations were too strict; and the cost of pollution control threatened international competitiveness.

Today, a new perception is emerging. Increasingly, a healthy environment is seen to complement economic performance. Though environmental protection adds to production costs, it also ensures that the land, forests, water and other resources continue to be productive. Destroying a fishery with pollution or a forest with acid rain affects incomes and employment in the same way as closing down a mine or a factory.

The economy and the environment are both highly complex systems, and they are interdependent. Accordingly, policies that protect our environment protect our long-term economic opportunities as well. The task is to design policies that recognize this interdependence by accomodating economic development while protecting human health and the integrity of the natural environment.

In Part II, we sketched the broad dimen-

sions of Canada's water resources, the demands we make on them and their value to us. The purely economic contribution of water in Canada, though seldom registered in conventional terms, is clearly enormous. But its value is not limited to economic uses. It plays a critical role in the natural environment, in providing recreation and aesthetic benefits, in supporting traditional native lifestyles, and in enhancing cultural values, the quality of life and a host of other values that defy measurement.

Water resources and the demands on them vary widely among regions in Canada, and so do the political and institutional arrangements for managing them. This complicates the federal role, and calls for sensitivity and flexibility in policy.

The Federal Role

The theme of this report is the need to clarify the federal role in water management in Canada. The federal government's water policy is not a unified body of objectives, programs and administrative arrangements, but, rather, a medley of activities, dispersed among many departments, each with its own responsibilities. Present arrangements appear to many observers, incoherent, confusing and vague.

The relationship between federal and provincial responsibilities for water management is also confusing and poorly understood, not only by the public at large, but also by corporations and others who must deal with governments. Even senior public servants admit they are sometimes uncertain about the scope of their responsibilities.

This inquiry has provided the first opportunity in Canadian history for a thorough, external, public assessment of federal water policy. So we began by identifying the fundamental responsibilities of the federal government and then proceeded to review the legislation, institutional arrangements and programs that constitute the federal government's water policy. We found that the division of constitutional responsibilities for water between the federal and provincial governments is not precisely defined; indeed, the constitution does not mention water.

Nevertheless, provinces clearly have general authority to manage water within their boundaries; but this provincial authority is overlaid by a variety of specific federal responsibilities that bear on water management, such as fisheries, Indian and northern lands, navigation and arrangements with the United States for international waters.

This constitutional division of powers for water-related matters means that federal and provincial responsibilities interact and overlap much more than is the case for other natural resources. To design a coherent water policy, these responsibilities must be reconciled.

The respective roles of governments is a sensitive issue in federal-provincial relations, and seems to have impeded resolution of some water management problems. Because federal and provincial responsibilities differ, they are not always mutually supportive; each constrains the other. But within these constraints, many opportunities exist for coordinating policies in the interests of efficient and harmonious water management.

So in our attempt to define the federal role, we have emphasized the importance of respecting the provinces' constitutional mandate while reconciling and coordinating water programs as much as possible. To do this, governments need to consult and inform one another about their policy objectives, to exchange information, to design complementary rather than conflicting programs, and to collaborate in programs of joint interest. Improved working relationships among governments was called for frequently in submissions at our public hearings, and would undoubtedly produce more effective water management in Canada.

We have concluded that the federal role in water management lies in meeting certain specific responsibilities. First, the federal government must attend to its particular management responsibilities, relating to navigation, fish habitat, northern resources, certain interjurisdictional waters, and so on. Second, it must promote resource conservation and development in the long-term economic and social interests of Canadians generally. This entails a concern for general environmental protection and resource development through policies relating to matters ranging from human health to international trade. Third, the federal government must provide leadership in resolving problems of an interjurisdictional nature and in providing a catalyst for addressing problems of national dimensions. Finally, it has a responsibility to

improve our knowledge about water resources in Canada, and develop our scientific capability for managing them. These responsibilities should guide the design of federal water policies and programs.

The Policy Framework

Our review of federal legislation for fulfilling these responsibilities, in Part III, reveals some shortcomings. We recommend the *Fisheries Act* be amended to facilitate integrated resource planning and watershed management. We also recommend that the *Environmental Contaminants Act* be changed so that the onus for identifying and registering toxic substances is shifted from the government to those who introduce them for sale or use. And we propose that certain features of legislation dealing with navigation and agriculture be reviewed. Finally, to deal with a growing number of conflicting demands on interjurisdictional waterways, we recommend changes to the *Canada Water Act* to ensure that disputes will be resolved whenever possible by agreement among the parties involved, but that the federal government will intervene if cooperation fails.

Because many of Canada's major waterways are shared with the United States, we have reviewed the provisions of international law, treaties and joint working arrangements for regulating our international interests. We have concluded that the existing formal arrangements are generally adequate, but that our main institution for reconciling U.S. and Canadian interests in water, the International Joint Commission, needs stronger support.

Issues and Programs

In Part IV, we proceeded to examine particular programs and policy issues. We began with an inventory of the federal government's water-related activities, which revealed a wide array of programs scattered among a large number of federal departments and agencies. According to our best estimates, more than $373 million is spent on these water-related programs annually.

We based our critique of these activities on certain basic principles we consider appropriate for modern water management. One of these principles is that the natural unit for managing water is the watershed, and management systems must recognise the interdependence of all the uses of land and water in watersheds that affect the flow and quality of the water. Thus, we recommend that the federal government explicitly endorse the principle of integrated watershed planning and management in designing its programs. Further, to promote integrated watershed planning and management, we recommend, among other things, that federal regulations under the *Fisheries Act* take into account the circumstances and needs of each watershed rather than simply applying uniform standards to all waters in Canada.

A second principle relates to demand management. We recommend that the government shift its policy from one that emphasizes increasing supplies to one that stresses managing demands. Most importantly, we recommend that the government adopt the principle that beneficiaries should pay for the water they use and the cost of providing it. This policy, which depends on cooperation with provinces, is intended not only to raise revenues but also to provide incentives to conserve resources, to distribute costs more equitably, and to foster individual and corporate responsibility in the use of water resources.

A third principle relates to the development of supplies. We recommend that all projects in which the federal government participates should be subject to rigorous and consistent evaluation to ensure that they are beneficial and that priorities are set in an orderly way. These evaluations should take into account environmental risks, uncertainties and the implications of irreversible decisions. For these reasons, we suggest special caution in considering projects that involve diversions of water from one basin to another.

A fourth principle is that policies, programs and projects must provide systematic avenues for public participation. The diversity and sensitivity of public interests in water management calls for special effort in public information, consultation and accountability.

We also recommend stronger federal initiatives to respond to new threats to water quality. These should include a more comprehensive program for preventing toxic and persistent substances from entering the natural environment, a vigorous effort to control acid rain, and a concerted approach toward establishing minimum standards for drinking water quality throughout Canada.

All these recommended changes in programs are designed to produce a water policy that responds to present and emerging needs. They call for increased attention to the management of water demand to balance the traditional emphasis on developing supplies; a more balanced consideration of all the direct and indirect benefits and costs associated with water developments; and increased reliance on the beneficiaries of water programs to bear their costs rather than taxpayers in general. They also imply a shift in policy priorities toward the new threats to water quality.

Our review of the federal water research effort points to a need for improved mechanisms for determining needs and research priorities. To provide this guidance, we recommend that a Water Resources Research Council be created. We also recommend, among other things, that federal support for water research in universities be focused in academic centres of excellence in water studies.

In general, we are favorably impressed with current programs for collecting and processing water-related data, many of them in cooperation with the provinces and territories. But we recommend increased attention to groundwater resources, to water quality monitoring, to information about northern resources and to the opportunities presented by remote sensing, satellite communications and other modern technology.

The last chapter in Part IV deals with water exports. Although there is little evidence of foreign demand for Canadian water, a variety of export proposals have recently generated considerable controversy, and we consider it important to clarify federal policy on this issue. We conclude that the federal government should regulate water exports but not necessarily prohibit them if they are approved by provincial governments and do not adversely affect federal or national interests. Accordingly, we recommend legislation to require exporters to obtain federal approval to export water, and we suggest criteria for granting approval.

We consider it important to distinguish between small-scale exports by means of tankers or local transborder piping systems and proposals for massive overland diversions of Canadian water to the United States. The latter raise profound economic, environmental and strategic questions, and we recommend that the government clarify whether it is prepared to consider such proposals. If it is, we propose a special procedure for evaluating and adjudicating applications to ensure they will advance the national interest.

Northern Responsibilities

Because of the wide federal responsibilities in Yukon and the Northwest Territories, and the special significance of water resources for northern development, we devote Part V to this subject. Important changes now taking place in the north — the settlement of native land claims, devolution of political responsibilities to territorial governments, and arrangements for administering water rights — complicate the requirements for an appropriate water management system.

The basic legislative and institutional framework for managing water resources in the territories appear to be well suited to northern conditions. But a number of urgent problems demand attention. We have therefore recommended clarification of the following: water licensing procedures, provisions for public hearings, the organization of territorial water boards and governmental responsibilities for resource planning. Other suggestions relate to more specific problems of northern water management, such as the environmental threat of abandoned mines and the regulation of Yukon placer mining.

Governmental Organization

The way the federal government organizes itself to develop and administer water policy is the subject of Part VI. We find that the wide dispersion of water-related programs among departments and agencies is to a large extent unavoidable, but we recommend two significant changes. First, we propose that the status of the lead agency for developing and coordinating water policy be raised from a Directorate to a Service, under an assistant deputy minister. Second, to respond to what we see as an urgent need for coordinating water programs within the government, we propose a considerable strengthening of the Interdepartmental Committee on Water.

We then devoted a special chapter to the problem of reconciling federal water policies with those of the provinces. To respond to the need for collaboration among governments, we recommend that the fed-

eral government initiate a National Water Conservation Program, which would enable provinces and territories to participate flexibly in a range of joint programs. General water conservation and development agreements between the governments would ensure consistent federal cost-sharing arrangements and provide for supplementary agreements on specific programs.

We also propose new intergovernmental consultative structures for developing and coordinating water policies, and provisions for a federal water policy coordinator in each province.

Finally, we address the need to stimulate public awareness of water resources and to develop channels for public participation in water policy decisions. We recommend a public information program be initiated with federal support but sustained mainly through collaboration with other organizations. To provide the government with continuing external advice on water policy and other environmental issues, we recommend that the Canadian Environmental Advisory Council be substantially reorganized to give it a higher public profile and strengthen its influence.

Shifting Priorities

In reforming federal water policy we do not, of course, start with a clean slate. We are constrained by the scope of federal constitutional powers, by the government's other responsibilities and resources, and to some extent as well by the established laws, institutions and programs. In formulating our recommendations we have tried to be pragmatic in building on existing arrangements and capabilities. We have not proposed an abrupt, wholesale reform, but rather a shift in direction to focus on new and emerging needs.

We have resisted the temptation to recommend expensive new programs. Although many problems could be addressed more easily with additional funds, we have been conscious of the current effort to restrain government spending. Moreover, our investigations have left us convinced that considerable opportunities exist for more effective federal effort through clarifying the federal responsibilities for water, identifying objectives and priorities, reallocating resources toward them and coordinating effort. This has been the thrust of our recommendations.

But pragmatism should not imprison us in the present. We must build on the past, but our approach must be forward looking. Stewardship of our natural resources calls for long-range vision and anticipatory policies that will prevent problems from occurring rather than depending on remedial measures. The public participation in this inquiry provides ample evidence that Canadians want stronger assurance that future generations will be able to continue to enjoy sufficient, safe and sustainable water resources.

Implementing Change

Policy development is a continuous process but, as we have seen, circumstances have sometimes converged to bring about bursts of change. We hope this inquiry will provide impetus for such a general redirection. Moreover, the pace at which external changes are occurring suggests that the government should review its water policy again within a few years, perhaps focusing on the particular problems of that time.

We have found that Canadians are in a receptive mood for changes in water policy. During the last couple of years water development projects and the problems of managing water quality have attracted unprecedented public attention. There is a new consciousness of our great rivers and lakes as part of the Canadian heritage, and of the need for better policies for managing and protecting them.

This Inquiry itself has contributed to public awareness of water resources, and heightened expectations of policy change. We hope it has also helped to facilitate change. It has generated more documentation and more public commentary on water policy than has ever before been assembled in Canada. We have been impressed not only with the breadth of participation in our public hearings but also by the number of private and public organizations that told us the process provided a catalyst to help them articulate their positions on water management. Our research and other publications have generated considerable interest as well.

This report contains 55 recommendations for improving federal water policy along with many less specific suggestions. Our proposals deal with issues ranging from fundamental policy positions to administrative details. Taken together, they are meant to clarify federal responsibilities for

water in Canada and to suggest a systematic organizational framework for meeting them. But our inquiry is only the first step in policy reform. It is now up to the government to take the next steps.

First, we hope that the government, notwithstanding its immediate reaction to our individual proposals, will authorize arrangements for our recommendations to be systematically reviewed and assessed. It would be appropriate for the Minister of the Environment to organize a small task force of senior representatives of appropriate departments and agencies to coordinate the review of this report and its recommendations.

The review should proceed on several fronts. The federal government must take into account the interest of provincial and territorial governments so the report should be reviewed with them. In particular, our recommendations in Chapter 15 for effecting collaborative arrangements with provinces and territories must be mutually acceptable. The Canadian Council of Resource and Environment Ministers appears to be the most suitable forum for this purpose.

Some of our recommendations involve changes in legislation. These will need to be examined by the Department of Justice and the other departments responsible for administering the relevant statutes. Our recommended changes in programs and administration will affect many more departments and agencies whose reviews must be coordinated.

Environment Canada has a more direct interest in this report than any other, and will undoubtedly need special internal arrangements for assessing our recommendations.

The Minister's task force could coordinate all these processes. Since the government is currently reviewing its major expenditure programs as well, the task force might usefully coordinate its work with that process as it relates to environmental activities.

Finally, we believe it is important to encourage continuing public discussion. This report will be widely circulated, and we expect it will generate considerable interest. The regular regional public consultations of Environment Canada will provide opportunities for public commentary and debate. Also, many private organizations have a special interest in water policy, and it may be useful for the government to collaborate with one or more of them in sponsoring conferences on water policy reform.

In the long run, an informed public provides the best assurance that water policy will respond to the currents of change.

Appendices

Appendix A

Terms of Reference

Given the distinctive geography of Canada and the character of water as a natural resource which has significant national and interjurisdictional dimensions, the Committee will report and make recommendations within 18 months on the following and, in particular, on specific strategies which the Government of Canada should adopt in support of such recommendations:

1) identify and substantiate the nature of emerging water issues, including the interjurisdictional dimensions thereof;
2) identify available supplies and future requirements for the conservation, development and utilization of water resources so as to ensure the enhancement of the health, well-being and prosperity of the people of Canada, including continued regional economic growth and the quality of the Canadian environment, together with estimates of benefits and costs where possible;
3) seek the views of governments and governmental bodies, private citizens, public groups, industry and the academic community with regard to such issues as future supplies and requirements;
4) assess the needs for and nature of additional scientific and research expertise in water management in Canada.

Appendix B

Biographies of Inquiry Members

Peter H. Pearse, chairman of the Inquiry, is a professor of forestry at the University of British Columbia specializing in natural resource management and development. Born in Vernon, British Columbia, he graduated from UBC with a bachelor's degree in forestry and later obtained his master's and doctor's degrees in economics from the University of Edinburgh, Scotland. Dr. Pearse recently served as a member of the board of governors at the University of British Columbia, and as federal Commissioner of Inquiry into the Pacific fisheries, and he also conducted a provincial royal commission on British Columbia's forest resources. Dr. Pearse's research and many publications reflect his special interest in the economics of natural resources and the environment, particularly forestry, fisheries, wildlife, recreation, and water resources. He is a former member of the Canadian Consumer Council and the Economic Council of Canada. He is currently a member of the United Nations' Advisory Committee on Marine Resources Research, and a member of the Forestry Research Advisory Council of Canada.

Françoise Bertrand, administrative dean at the Université de Québec à Montréal (UQAM), graduated from Collège Sainte Marie, Montréal, in sociology and holds a master's degree in environmental studies from York University, Toronto. Born in Montréal, August 6, 1948, she has divided her career between research and consulting work in the field of communications, part-time teaching, and university administration at UQAM. She has written a wide range of publications reflecting her special interest in environmental subjects, communications and culture, community organizations and recreation, and public opinion and advertising.

James W. MacLaren brings to the Inquiry a career of experience with an engineering consulting firm engaged in some of Canada's major projects of water supply and distribution, sewerage and sewage disposal, drainage and flood control. Chiefly as former head of James F. MacLaren Limited, Toronto, now a division of Lavalin, he has been engaged in projects in his home city and province, as well as in Manitoba, British Columbia, and the Atlantic provinces, and in Africa, the Mediterranean, and the Caribbean. Mr. MacLaren is a past president of the Association of Consulting Engineers of Canada. He now practises as an individual consultant in Toronto. Born in 1921, Mr. MacLaren interrupted his civil engineering course at University of Toronto to serve in the wartime army and graduated in 1946. The following year he received a master's degree in sanitary engineering from the Massachusetts Institute of Technology.

Appendix C

Inquiry Staff

Executive Director	Elizabeth Dowdeswell
Research	Frank Quinn, Director Bernard Madé
	During the course of the Inquiry we were assisted by a number of people. Specifically we are grateful to Deborah MacDonald McGee and Donald McGirr who served as researchers. David Percy, Tony Hodge, Glynnis Horel, John Stone and Nola Seymoar advised us as technical consultants. Of great assistance were members of the Inland Waters Directorate of Environment Canada.
Administration	Jan Glyde Marjorie Brown Watts
	Secretarial and office support was provided by Ginette Dean, Lise Saucier and Josée Beaumier.
Publications	John McHale Tim Creery
	In producing the final report a helpful team included graphic designer Ghyslaine Ouellet, the drafting division of Environment Canada, Interpretcan and Ginette St-Laurent for translation services and Carter Communications for editing services.

Appendix D

List of Submissions and Participants

A schedule of public hearings was arranged by the Inquiry to provide for the hearing of submissions, and discussion with participants, at 17 centres across Canada. The hearings opened in Halifax, September 18 and concluded in Ottawa on December 16, 1984. The hearings lasted for a total of 33 days and involved at least one hearing in each province and territory. 201 oral presentations were made by individuals and organizations at the hearings and the Inquiry received a total of 313 written briefs.

Submission number	Organization	Participants	Location	Date
198	Agriculture Canada	R. Bailey Dr. J. Girt M. John	Ottawa	7 Dec. 1984
025	Alberta Fish and Game	E. Kure	Calgary	10 Oct. 1984
083	Alberta Wilderness Association	B. Taylor	Calgary	10 Oct. 1984
190	Associate Committee on Hydrology of the National Research Council of Canada	F. Cardy	Ottawa	4 Dec. 1984
101	Association of British Columbia Professional Foresters	R. Christie	Kelowna	28 Nov. 1984
240	Association of British Columbia Grape Growers	T. Wells	Kelowna	28 Nov. 1984
019	Association of Consulting Engineers	R. MacDonald W. Delbecke	Regina	22 Oct. 1984
208	Association of Consulting Engineers	V. Morris R. Goodings R. Pineault	Ottawa	6 Dec. 1984
014	Association of Professional Engineers	R. Burrage B. Burrows K. Davar	Fredericton	20 Sept. 1984
213	Association of Professional Biologists of British Columbia	G. Alexandra E. Vernon	Victoria	26 Nov. 1984
040	Association pour l'aménagement de la Rivière-des-Prairies	M. Garand J.H. Garand	Montreal	5 Nov. 1984
151	Association québécoise des techniques de l'eau	D. Lapointe	Montreal	Nov. 1984
233	Association québécoise de l'industrie du nautisme	A. Bélair O. Laurendeau R. Leblanc	Montreal	6 Nov. 1984

002	Atlantic Canada Section, American Water Works Association	W. D'Eon D. Ryan W. Gates	Halifax	19 Sept. 1984
064	B.C. Water Well Drilling Association	A. Hammelin R. McNichol E. Livingston	Vancouver	19 Nov. 1984
171	B.C. Wildlife Federation	M. Halloran	Vancouver	19 Nov. 1984
008	Barnes, Jeffrey L.	J.L. Barnes	St. John's	24 Sept. 1984
130	Biological Survey of Canada	Dr. I. Smith Dr. H.V. Danks	Ottawa	3 Dec. 1984
193	Brenda Mines	G. Harris	Kelowna	28 Nov. 1984
099	British Columbia Provincial Executive of the Communist Party of Canada	M. Figueroa	Vancouver	23 Nov. 1984
076	British Columbia Watershed Protection Alliance	H. Hammond	Vancouver	22 Nov. 1984
229	Caccia, Hon. C.	Hon. C. Caccia	Ottawa	10 Dec. 1984
017	Calgary Aquarium Society	D. Speirs	Calgary	9 Oct. 1984
041	Cameron, D.	D. Cameron	Winnipeg	25 Oct. 1984
079	Canada West Foundation	D. Elton	Calgary	10 Oct. 1984
207	Canadian Arctic Resources Committee	Dr. T. Fenge P. Burnet	Ottawa	4 Dec. 1984
142	Canadian Coalition on Acid Rain	A. Hurley	Toronto	1 Nov. 1984
104	Canadian Environmental Law Association	T. Vigod	Toronto	31 Oct. 1984
155	Canadian Environmental Law Research Foundation	M. Valianté	Toronto	2 Nov. 1984
170	Canadian Labour Congress	Shirley Carr R. Peters C. Adam	Ottawa	6 Dec. 1984
005	Canadian Meteorological and Oceanographic Society	Dr. R.H. Loucks	Halifax	19 Sept. 1984
145	Canadian National Committee of the Sierra Club	A. Timmins	Toronto	2 Nov. 1984
134	Canadian Nature Federation	G. Sheehy	Ottawa	3 Dec. 1984
118	Canadian Organic Producers Marketing Cooperative Ltd.	E. Laird	Saskatoon	23 Oct. 1984
157	Canadian Pulp and Paper Association	H. Hart D. Paavila	Ottawa	7 Dec. 1984
191	Canadian Society of Environmental Biologists	J. Allen	Ottawa	4 Dec. 1984
177	Canadian Water Resources Association	A.J. Robinson	Ottawa	7 Dec. 1984
125	Canadian Water Well Association	W. Hnatiuk	Winnipeg	25 Oct. 1984
203	Canadian Wildlife Federation	L. Hazell D. Gimmer	Ottawa	4 Dec. 1984

186	Carrier Sekani Tribal Council	R. Salter	Vancouver	23 Nov. 1984
027	City of Calgary	Commissioner R.A. Welin	Calgary	9 Oct. 1984
029	City of Saint John	N. Barfoot W. Butler	Fredericton	20 Sept. 1984
126	City of Selkirk	Mayor B. Oliver A. Dmitruk	Winnipeg	25 Oct. 1984
113	City of Toronto, Department of Public Health	Dr. A.S. Macpherson Dr. K. Davies	Toronto	30 Oct. 1984
115	City of Winnipeg	Mayor W. Norrie	Winnipeg	25 Oct. 1984
183	Coast Mountain Aquasource Limited	C. Beach	Vancouver	22 Nov. 1984
196	Communist Party of Canada, Central Committee	G. van Houten	Ottawa	6 Dec. 1984
147	Concerned Citizens for Water Level Management	W.R. Darker	Toronto	2 Nov. 1984
015	Concerned Citizens of Peachland	G. Rouw	Kelowna	28 Nov. 1984
057	Conservation Council of Ontario	G. Harrington	Toronto	31 Oct. 1984
022	Conservation and Development Association	F. Petroff G. Young	Regina	22 Oct. 1984
181	Consumers' Association of Canada (British Columbia Branch)	M. Anderson B. Asselstine R. Lotzker M. Roseblade	Vancouver	21 Nov. 1984
062	Corporation of the District of Peachland	M. Dodd	Kelowna	28 Nov. 1984
068	Council of Forest Industries of British Columbia	B. Affleck D. Bryan C. Rathburn	Vancouver	21 Nov. 1984
039	Cumberland House Band	S. Laliberté	Regina	22 Oct. 1984
129	Davies, L.B.	L.B. Davies	Vancouver	21 Nov. 1984
093	Dene Nation	L. MacLachlan S. Kafkwi Chief R. Beaver A. Barnaby	Yellowknife	16 Oct. 1984
199	Department of Energy, Mines and Resources	Dr. H. Rothschild Dr. J. Fowles M. Warnes	Ottawa	6 Dec. 1984
231	Department of External Affairs	S.E. Gooch	Ottawa	10 Dec. 1984
172	Department of Fisheries and Oceans	Hon. J. Fraser Dr. A. May J. Lark	Ottawa	6 Dec. 1984
192	Department of National Health and Welfare	Dr. E. Somers J.R. Hickman	Ottawa	3 Dec. 1984
173	Department of the Environment	J. Gérin R. Pentland	Ottawa	5 Dec. 1984
184	Dobyns, D.	D. Dobyns	Vancouver	23 Nov. 1984

144	Dofasco	M. Greenfield	Toronto	2 Nov. 1984
026	Dominion Ecological Consulting Limited	S. Stephansson	Calgary	9 Oct. 1984
050	Ducks Unlimited	R. Coley W. Cowan	Winnipeg	25 Oct. 1984
023	Electric Utility Planning Council	D. Frey Dr. J. Railton	Calgary	10 Oct. 1984
103	Emberley, K.	K. Emberley	Winnipeg	25 Oct. 1984
001	End of the Line	M. Clifton	Montreal	5 Nov. 1984
028	Environment Canada, Atlantic Region	D. Brack Z. Davar B. Power	St. John's	24 Sept. 1984
047	Environment Canada, Ontario Region	Dr. J. Kingham K. Ogilvie	Toronto	30 Oct. 1984
136	Environment Canada, Pacific and Yukon Region	J. Wiebe I. Clark B.A. Heskin	Vancouver	22 Nov. 1984
020	Environment Canada, Western and Northern Region	Dr. A.H. Macpherson G. Morton	Calgary	10 Oct. 1984
033 035	Environmental Law Centre	L. Duncan D. Tingley	Edmonton	12 Oct. 1984
167	Environmental Mediation International Incorporated	G. Grenville-Wood	Ottawa	10 Dec. 1984
237	Environmental Resource Centre	B. Staszenski C. Freeman M. Cooper	Edmonton	12 Oct. 1984
154	Farquharson, K.G.	K.G. Farquharson	Vancouver	21 Nov. 1984
188	Federation of Associations on the Canadian Environment	D. Simpson D. Ryan	Ottawa	3 Dec. 1984
128	Federation of Canadian Municipalities	W. Curtis J. Hall	Vancouver	20 Nov. 1984
110	First Watercount Systems Limited	Y. Bajard Dr. P. McLoughlin	Vancouver	20 Nov. 1984
070	Fisheries Council of British Columbia	M. Burgess	Vancouver	23 Nov. 1984
119	Fond du Lac Indian Band	D. Deranger	Saskatoon	23 Oct. 1984
225	Friends of the Earth	R. Vles	Ottawa	10 Dec. 1984
003	GRAND Canal Company Limited	T. Kierans H. Snyder A. Bruneau	St. John's	24 Sept. 1984
044	Gale, John	J. Gale	St. John's	24 Sept. 1984
122	Gallop, Professor R.A.	R.A. Gallop	Winnipeg	24 Oct. 1984
158	Gitskan-Wet'suwet'en Tribal Council	N. Sterritt R. Overstall	Vancouver	21 Nov. 1984
141	Goering, J.W.L.	J.W.L. Goering	Toronto	1 Nov. 1984
153	Goldsmith, B.	B. Goldsmith	Montreal	5 Nov. 1984
132	Gordon, Dr. D.	Dr. D. Gordon	Vancouver	21 Nov. 1984

009	Government of New Brunswick, Department of the Environment	Hon. C.W. Harmer B. Barnes	Fredericton	20 Sept. 1984
053	Government of Northwest Territories, Department of Renewable Resources	Hon. N. Cournoyea J. Donohy	Yellowknife	16 Oct. 1984
031	Grantham, David A.	Dr. D.A. Grantham	Halifax	18 Sept. 1984
162	Graystokes Monitoring Committee	G. Huva	Kelowna	28 Nov. 1984
168	Great Lakes Institute	Dr. M. Sanderson	Ottawa	5 Dec. 1984
204	Great Lakes United	R. Boice D. Green	Ottawa	5 Dec. 1984
215	Greater Vernon and District Environmental Committee	D. Warrington W. McGrath	Kelowna	28 Nov. 1984
182	Green Party of British Columbia	Paul George	Vancouver	22 Nov. 1984
082	Harrison, Derrick	D. Harrison	Calgary	10 Oct. 1984
127	Howard, R.	R. Howard	Winnipeg	25 Oct. 1984
140	Hunter, R.	R. Hunter	Toronto	31 Oct. 1984
226	Hunter, R.	R. Hunter	Ottawa	7 Dec. 1984
060	Indian Affairs and Northern Development, Dept of	Dr. W. Stephen A. Cullen A. Boutilier	Yellowknife	16 Oct. 1984
061	Indian Affairs and Northern Development, Department of, Yukon Region	A.E. Gatsky G. Whitley	Whitehorse	15 Oct. 1984
228	Indian Affairs and Northern Development	Hon. D. Crombie	Ottawa	10 Dec. 1984
038	Inland Waters Directorate, Environment Canada, Western and Northern Region	R. Halliday D. Bjonback	Regina	22 Oct. 1984
072	International Woodworkers of America Local #1-423	R. Leibel	Kelowna	28 Nov. 1984
176	Islands Trust, Ministry of Municipal Affairs	Dr. M. Humphreys	Victoria	26 Nov. 1984
108	James Bay Crees	Grand Chief T. Moses W.S. Grodinsky A. Penn	Montreal	5 Nov. 1984
210	Keenan, C.	C. Keenan	Victoria	26 Nov. 1984
087	Kostuch, Dr. M.	Dr. M. Kostuch	Edmonton	12 Oct. 1984
109	Lakehead Region Conservation Authority	R. Hartley	Toronto	2 Nov. 1984
239	Lambton Industrial Society	R. Denning	Toronto	2 Nov. 1984
175	Lifeforce Foundation	P. Hamilton	Vancouver	22 Nov. 1984
161	Lillooet Tribal Council	Chief P. Redan J. McCandless	Vancouver	19 Nov. 1984

232	MacDonald, D.R.	W.L.S. Trivett	Ottawa	10 Dec. 1984
238	Manitoba Department of Environment and Workplace Safety and Health	N. Branson	Winnipeg	24 Oct. 1984
121	Manitoba Environmental Council	Dr. D. Malley	Winnipeg	24 Oct. 1984
058	Manitoba Natural Resources	R.L. Carter T. Weber	Winnipeg	24 Oct. 1984
037	Manitoba Water Commission	D. Duncan Dr. T. Ball	Winnipeg	25 Oct. 1984
049	Marean, John	J. Marean	Calgary	10 Oct. 1984
139	Metropolitan Toronto Water Pollution Committee	T. O'Donohue	Toronto	31 Oct. 1984
150	Mohawk Council of Kahnawake	Grand Chief J. Norton J. Montour S. Delisle	Montreal	5 Nov. 1984
042	Morell and Area Land Use Steering Committee	D. Guignion	Charlottetown	26 Sept. 1984
077	Nechako Neyenkut Society	L. Kaneen C. Hooper	Vancouver	21 Nov. 1984
133	Nechako Steering Committee	L. Kaneen Dr. A. Thompson	Vancouver	19 Nov. 1984
178	Nishga Tribal Council	Chief J. Gosnell Chief R. Robinson H. Doolan L. Guno J. Aldridge	Vancouver	19 Nov. 1984
071	Nishnawbe-Aski Nation	Deputy Grand Chief B. Cheechoo	Toronto	31 Oct. 1984
202	Noranda Incorporated	H. Veldhuizen M. Wiber	Ottawa	6 Dec. 1984
092	Northern Canada Power Commission	J. Smith M. Foster J. McEachen	Whitehorse	15 Oct. 1984
052	Northwest Territories Chamber of Mines	W.A. Case	Yellowknife	16 Oct. 1984
096	Northwest Territories Water Board	G. Warner C. Kennedy W. Lyle	Yellowknife	16 Oct. 1984
006	Nova Scotia Department of the Environment	A.H. Abbott Dr. J. Jones Dr. C. Ling H. Windsor	Halifax	18 Sept. 1984
030	Nova Scotia Department of Health	P. Casey	Halifax	18 Sept. 1984
034	Nova Scotia Federation of Agriculture	D. Downe L. Lettle	Halifax	19 Sept. 1984
214	Okanagan Basin Water Board	E. Lamont G. Armour	Kelowna	28 Nov. 1984

138	Ontario Federation of Anglers and Hunters	L.B. Males	Toronto	31 Oct. 1984
063	Ontario Hydro	G. Wilson R. Yorke	Toronto	30 Oct. 1984
149	Ontario Ministry of Natural Resources	H.A. Clarke R. Milligan	Toronto	30 Oct. 1984
137	Ontario Provincial Secretariat for Resources Development	Hon. N.W. Sterling W. Stagles	Toronto	30 Oct. 1984
045	Ontario Section, American Water Works Association	J.D. Pawley	Toronto	2 Nov. 1984
169	Ontario Society for Environmental Management	M. Stagg	Ottawa	6 Dec. 1984
098	Ontario Water Well Association	P. McFarlane W. Morrison	Toronto	31 Oct. 1984
073	Ordre des ingénieurs du Québec	R. Arsenault J.-P. Dagenais M. Slivitzsky N. El Jabi P. Béron R. Boivin	Montréal	6 Nov. 1984
227	Ottawa Chapter of the Canadian Meteorological and Oceanographic Society	G. Holland	Ottawa	10 Dec. 1984
131	Ottawa Field-Naturalists' Club	Dr. R. Taylor	Ottawa	10 Dec. 1984
124	Paddlewheel Riverboats	Dr. J. Slocan	Winnipeg	25 Oct. 1984
080	Peigan Band	Chief Yellowhorn W. Big Bull Jr.	Calgary	10 Oct. 1984
088	Pembina Institute for Appropriate Development	R. MacIntosh	Edmonton	12 Oct. 1984
189	Peter Ward and Associates Limited	Dr. P. Ward	Vancouver	20 Nov. 1984
174	Petroleum Association for Conservation of the Canadian Environment	H. Carter P. Hunt	Ottawa	6 Dec. 1984
123	Pip, Dr. E.	Dr. E. Pip	Winnipeg	24 Oct. 1984
313	Pleva, Mr. Ed	Mr. Ed Pleva	London	24 Apr. 1984
046	Prairie Association for Water Management	A. New	Calgary	9 Oct. 1984
117	Prairie Farm Rehabilitation Administration	B. Lukey R. Wettlaufer	Regina	22 Oct. 1984
086	Prepas, Dr. E.E. and Dr. W.C. Mackay	Dr. E.E. Prepas Dr. W.C. Mackay	Edmonton	12 Oct. 1984
043	Prince Edward Island Ministry of Community and Cultural Affairs	R. Francis	Charlottetown	26 Sept. 1984
021	Queenstake Resources Limited	G. Gutrath	Whitehorse	15 Oct. 1984

230	Rawson Academy of Aquatic Science	Dr. A.L. Hamilton	Ottawa	10 Dec. 1984
205	Regier, Dr. H.A.	Dr. H.A. Regier	Ottawa	10 Dec. 1984
185	Regional District of Fraser-Cheam	P. Nash	Vancouver	23 Nov. 1984
016	Régnier, M.J.	M.J. Regnier	Winnipeg	25 Oct. 1984
256	Russell, Professor D.	D. Russell	Vancouver	23 Nov. 1984
065	STOP	C. Mallory D. Morton	Montreal	5 Nov. 1984
212	Saanich Peninsula Farmers Institute	A. Garcia	Victoria	26 Nov. 1984
010	Saint John River Basin Hydrology Committee	G. Lockhart	Fredericton	20 Sept. 1984
012	Saskatchewan Urban Municipalities	R. Wankling	Regina	22 Oct. 1984
197	Saskatchewan Water Corporation	D. MacLeod	Ottawa	4 Dec. 1984
120	Saskatchewan Water Well Association	D. Tweidt	Saskatoon	23 Oct. 1984
116	Saskatchewan Wildlife Federation	L. Scott	Regina	22 Oct. 1984
112	Save Our Streams	S. Agnew D. M'Keown	Toronto	31 Oct. 1984
180	Save the Bulkley	P. Moss	Vancouver	20 Nov. 1984
084	Science Advisory Committee of the Environment Council of Alberta	G. Sykes	Calgary	10 Oct. 1984
179	Sierra Club of Western Canada, Lower Mainland Group	A. Buffinga G. Okrainetz	Vancouver	19 Nov. 1984
107	Sierra Club of Western Canada	M. Doherty	Victoria	26 Nov. 1984
094	Slave River Basin Coalition	J. van Pelt	Yellowknife	16 Oct. 1984
095	Slave River Development Impact Zone	D. Ferguson M. Wallis	Yellowknife	16 Oct. 1984
154	Société pour vaincre la pollution	M. Marc D. Green	Montreal	6 Nov. 1984
211	Society Promoting Environmental Conservation	J. Erkilitian E. Feller W. Paulik	Victoria	26 Nov. 1984
059	South Okanagan-Similkameen Union Board of Health	Dr. E. Warrendorf	Kelowna	28 Nov. 1984
111	Southern Interior Group of the Sierra Club of Western Canada	R. Domer A. Curry	Kelowna	28 Nov. 1984
146	Spence, Dr. E.	Dr. E. Spence	Toronto	2 Nov. 1984
051	Stagg, Mark	M. Stagg	Toronto	1 Nov. 1984
135	Templeton, C.H.	C.H. Templeton	Victoria	26 Nov. 1984

089	Thompson, Dr. Dixon	Dr. D. Thompson	Calgary	10 Oct. 1984
209	Transport Canada	M. Turner	Ottawa	5 Dec. 1984
074	Trout Unlimited	R. Hoffman D. Reid	Toronto	1 Nov. 1984
152	Union des municipalités du Québec	J. Corbeil	Montreal	5 Nov. 1984
164	Union of British Columbia Indian Chiefs	D. Hoggan M. Poplar R. Tizya	Vancouver	23 Nov. 1984
032	Union of New Brunswick Indians	G. Nicholas G. Sewell D. Ward	Fredericton	20 Sept. 1984
048	Union of Ontario Indians	A. Roy	Toronto	1 Nov. 1984
106	Victoria Group of the Sierra Club of Western Canada	S. Chow	Victoria	26 Nov. 1984
141	Walpole Island Band Council	Chief W. Choochanik I. Jacobs	Toronto	1 Nov. 1984
081	Waterton Biosphere Reserve Management Committee	B. Lieff	Calgary	10 Oct. 1984
007	West Kootenay Power and Light Company Limited	J.A. Drennan	Kelowna	28 Nov. 1984
000	Westcoast Environmental Law Association	M. Kansky	Vancouver	21 Nov. 1984
201	Wilkinson, Dr. T.P.	Dr. T.P. Wilkinson	Ottawa	4 Dec. 1984
018	Williams, Dr. C.M.	C.M. Williams	Saskatoon	23 Oct. 1984
091	Yukon Association of Wilderness Guides	J. Lammers	Whitehorse	15 Oct. 1984
090	Yukon Conservation Society	T. Hodge J. Morrow T. Munson	Whitehorse	15 Oct. 1984

Appendix E

List of Supplementary Documents

Number	Submitted by	From	Date
013	Abrahams, B.	Willowdale	9 September 1984
195	Alberta Waterwell Drilling Association	Lousana	29 October 1984
264	Alchem Inc.	Burlington	14 June 1984
302	Amalgamated Conservation Society	Victoria	January 1985
265	Association of Biologists of Quebec	Montreal	7 May 1984
250	Association of Conservation Authorities of Ontario	King City	13 December 1984
036	Athabasca Chipewyan Indian Band	Fort Chipewyan	23 August 1984
097	Bayly, J.V. and B.A. Hubert	Yellowknife	16 October 1984
266	Beaubien, C.	Ottawa	8 August 1984
267	Beck, A.	Pembroke	24 February 1984
263	Berniard, M.	Ste-Foy	31 January 1985
258	Boerma, H.R.	Saskatoon	11 January 1985
166	Bray, Dr. D., University of New Brunswick	Fredericton	2 November 1984
114	British Columbia Aboriginal Peoples' Fisheries Commission	Vancouver	12 October 1984
268	Brown, D.	Toronto	27 January 1984
102	Buck Creek Residents' Association	Buck Creek	22 October 1984
160	Budding, U.	Port Alberni	13 November 1984
270	Canada Mortgage and Housing	Ottawa	27 November 1984
100	Canadian Electrical Association	St. John's	15 October 1984
241	Canadian Federation of Agriculture	Ottawa	18 December 1984
078	Canadian Society of Environmental Biologists	Edmonton	28 November 1984
236	Central Interior Steelheaders Association	Kamloops	9 October 1984
248	Centre for Water Resource Studies	Halifax	3 December 1984
251	City of Saskatoon	Saskatoon	13 December 1984
269	Claverley, F.H.	Carman	15 May 1984
105	Cooper, Mike	Cowley	22 October 1984
272	Crookewit, J.	Kelowna	18 January 1985
067	Define Design	Edmonton	15 October 1984
273	Dominion Marine Association	Ottawa	11 July 1984
004	Drinkwater, K.	Dartmouth	3 September 1984
274	Emergency Planning Canada	Ottawa	13 November 1984
298	Fast, G.	Kitchener	5 February 1985

234	Federation of Mountain Clubs of British Columbia, Vancouver & Outdoor Recreation Council of British Columbia	Vancouver	6 December 1984
275	Ferguson, W.M.	Sault Ste. Marie	28 May 1984
276	First Nations of South Island Tribal Council	Mill Bay	11 September 1984
262	Fraser, M.M.	New Glasgow	September 1984
243	Fulmer, J.	Rodney	3 December 1984
277	Furlott, R.A.	Thunder Bay	13 June 1984
278	Fuykschot, C.	Gananoque	16 July 1984
254	Gardiner, M.	Grace Bay	5 December 1984
217	Green Party of Canada, Okanagan-Similkameen Riding Association	Maple Ridge	28 November 1984
280	Hendrick, W.	Newdale	26 April 1984
259	Herring, G.	Toronto	11 January 1985
281	Hydrometric Services Limited	Calgary	20 September 1984
260	Independent Mineral Developers Association	Saskatoon	7 January 1985
219	Kellar, J.	Vancouver	13 November 1984
218	Ker, A.	Victoria	23 November 1984
247	Lakefront Owners Association	Toronto	14 November 1984
261	Lasich, A.	Marlelin	5 December 1984
301	Laycock, Dr. Arleigh H.	Edmonton	6 February 1985
056	Liebau, W.	Fenwick	3 September 1984
283	MacDonald, S.	Sault Ste. Marie	August 1984
224	Marchant, K.	Toronto	30 November 1984
284	Marston, J.	Aurora	November 1984
255	McKenzie, P.	Winnipeg	12 November 1984
054	Meewasin Valley Authority	Saskatoon	28 September 1984
245	Newfoundland Power and Light Co. Ltd.	St. John's	11 November 1984
285	Niagara Peninsula Conservation Authority	Allanburg	15 October 1984
066	North Salt Spring Waterworks District	Ganges	10 October 1984
286	Nova Scotia Power Corporation	Halifax	31 August 1984
300	Oliver Women's Institute	Oliver	
069	Ontario Ministry of Agriculture and Food	Toronto	3 October 1984
299	Ontario Ministry of the Environment	Toronto	30 January 1985
206	Pacific Science	Cobble Hill	23 November 1984
055	Pallister Resource Management	Calgary	11 September 1984
249	Peachland Irrigation District	Peachland	10 December 1984
257	Pilon Jr., E.	Elliot Lake	15 January 1985
313	Pleva, Mr. Ed	London	24 April 1984
287	Prior, J.G.	Victoria	July 1984
246	Project North (Victoria)	Victoria	a) 27 November 1984 b) 28 February 1985

220	Provincial Council of Women of B.C.	North Vancouver	November 1984
309	Qu'Appelle Valley Indian Authority	Regina	30 April 1985
288	Ray, Dr. A.K.	Ontario	June 1984
289	Richardson, H.E.	Victoria	2 May 1984
156	Rutledge, L.	Hudson's Hope	1 October 1984
290	Sankey, W.	North Vancouver	15 June 1984
011	Saskatchewan Research Council	Saskatoon	6 September 1984
148	Save the Rouge Valley System	Markham	1 November 1984
252	Sewell, J.	Kingston	19 December 1984
253	Shannon, F.	Summerland	15 December 1984
222	Shelton, S.	Mission	December 1984
291	Sheppard, E.	Toronto	21 June 1984
292	Shipping Federation of Canada	Montreal	16 October 1984
242	Sierra Club of Western Canada, Alberta Group	Calgary	29 November 1984
075	Slocan Valley Watershed Alliance	Winlaw	15 October 1984
216	South Okanagan Environmental Coalition	Penticton	28 November 1984
293	Sparrow, D.F.	Brandon	11 May 1984
024	Stark, J.K.	Oliver	13 September 1984
294	Stark, M.	Montreal	25 April 1984
235	Storgaard, L.	Kelowna	13 December 1984
244	Summerland Sportmen's Association and Okanagan Region Branch, B.C. Wildlife Federation	Summerland	7 December 1984
187	Sunshine Coast Regional District	Sechelt	20 November 1984
221	Thompson, J.E.	Vancouver	November 1984
163	Toronto Field Naturalists	Toronto	6 November 1984
085	Treaty Eight Tribal Association	Fort St. John	12 October 1984
165	Tungavik Federation of Nunavut, Land Claims Project	Ottawa	5 November 1984
295	Vandestadt, G.	Owen Sound	25 June 1984
200	Watson, A.S.	Burlington	a) 7 November 1984 b) 28 April 1984
296	Western Canada Wilderness Committee	Vancouver	26 October 1984
223	Zaltsberg, Dr. E.	Toronto	7 November 1984

Appendix F
Research Papers

The Inquiry commissioned research papers on a variety of special problems of water policy. The research was done by recognized authorities in each field. The Inquiry published their reports in the form of research papers listed below. These may be obtained from the Enquiry Centre, Environment Canada, Ottawa K1A 0H3.

Number	Author	Title
1	**Harriet Rueggeberg and Andrew Thompson**	**Water Law in Canada**
	The paper provides an overview of basic water law in Canada. It is based on the results of a workshop and focuses on legal issues associated with the constitutional allocation of powers, interjurisdictional rivers, northern waters, Indian rights to water and Canada-United States relations respecting boundary waters. The text is written for the nonlawyer.	
2	**F. Kenneth Hare**	**The Impact of Human Activities on Water in Canada**
	The paper reviews in broad terms the degradation of the Canadian environment by forest cutting, agricultural, urban and industrial development. Acid deposition has taken its toll and future climatic change could reduce water supply in many areas. Good water science — already available — is proposed in the report as one of the keys to remedial action.	
3	**J.W. MacLaren**	**Municipal Waterworks and Wastewater Systems**
	The paper indicates that more than 8 million Canadians reside in municipalities where as yet no sewage treatment has been provided to protect the receiving waters and other uses. Where it does exist, significant rehabilitation programs are needed to sustain aging systems whose current replacement value is estimated at over $100 billion. The report recommends that the federal government with the provinces develop programs to catalyze municipal spending in these important areas.	
4	**Brian Grover and David Zussman**	**Safeguarding Canadian Drinking Waters**
	An overview of the state of Canadian drinking water, focused particularly on quality issues, the legislative and regulatory framework and relevant federal programs. The report strongly emphasizes the need for the federal government to cooperate with provincial and local governments in order to safeguard Canadian drinking waters.	
5	**R. Andrew Muller**	**The Socioeconomic Value of Water in Canada**
	This paper attempts to clarify the concept of the economic value of water and to estimate its value in the present economy. In the withdrawal uses category, the value of water is estimated for municipal, agricultural, thermal cooling and manufacturing uses. For instream uses, the same evaluation is done for hydroelectricity, waste assimilation services, recreational and other uses and commercial navigation and fishing. The total value of water for the identified uses may range from $7.5 to $23 billion annually. The use of water in its natural setting appears to have a high value for Canadians.	

6	**J.C. Day**	**Canadian Interbasin Diversions**

Canadians have long experience in interbasin water transfer on which to base judgments concerning the desirability and management of future projects. Enormous progress has been made in planning hydroelectric diversions over the past four decades. The paper suggests that more effective institutional arrangements are needed to reconcile federal and provincial management responsibilities.

7*	**Anthony Scott**	**The Economics of Water Export Policy**

Economic aspects of the water export issue are addressed, as are means for economic analysis to contribute to Canadian policy on this subject. Federal and provincial governments are encouraged to prepare a policy on water export which includes what bodies should be formed, what information should be collected and what procedures set out for reviewing proposals.

8	**David G. LeMarquand**	**Boundary Water Relations and Great Lakes Issues**

Some of the main features of Canada-United States boundary water relations are reviewed and some current Great Lakes problems are examined to provide a perspective on the problems and opportunities for cooperative management of boundary water resources.

9	**Denis DePape**	**Federal/Provincial Cooperation in Water — An Exploratory Examination**

This paper explores the recent history of water-related federal-provincial co-operation. Basin planning agreements, issue-oriented agreements, province-wide agreements as well as informal arrangements are addressed. Particular emphasis is placed on identifying and discussing alternative approaches to such cooperation in the future.

10	**R.D. Schwass**	**Public Information and Participation in Water Resources Policy**

Reviews recent events and the results of a workshop discussion of public consultation issues with respect to federal water policy. Among the suggestions are improvement of Environment Canada's public information and participation programs, and a national water commission which might work with all levels of government to develop better public understanding of Canada's future issues and options.

11	**Peter Gossage**	**Water in Canadian History: An Overview**

Use and development of water in Canada are described from earliest times until 1960 in a social and economic context. Attention is given to the evolution of major water uses in different regions. Finally, it focuses on the role of the federal government in the development and management of water resources in the period spanning 1870 to 1930.

12	**Harriet Rueggeberg**	**Northern Water Issues**

Examining the legal and administrative context in the North, northern water uses, planning and management, the possible impact of aboriginal rights on water management and water diversion and export as viewed from the North, the paper proposes measures to improve federal water administration in the territories.

13	**Owen V. Washburn**	**The Saint John River: Deterioration and Restoration**

This paper traces developments in the Saint John River Basin from the end of World War II to the present. It examines the impacts of industrial and economic development on water resources as well as governments' efforts to restore a balance of water resource uses. The continuing role of federal and provincial governments in managing water quality in the basin is reviewed for effectiveness.

14	**J.A. Vonhof**	**Groundwater Issues: An Overview**

Groundwater is a neglected resource in Canada although over 25 percent of the population relies on it as a source of drinking water, and limitations of surface water resources in certain regions may force this percentage to increase in the future. The author tries to display the implications of groundwater extraction as well as the present and possible pressures of contamination. The role of the federal government in research, planning and data collection related to groundwater is also discussed.

15	**John S. Mactavish**	**The Federal Role in Water Management**

This paper assesses major federal legislation, policies and programs related to water resource management in Canada, exclusive of Yukon and Northwest Territories. It describes the constitutional setting including its uncertainties. Recommendations are presented to improve legislation and to strengthen a number of major federal programs.

16**	**Bruce Mitchell and Edward McBean**	**Water Resources Research in Canada: Issues and Opportunities**

This paper provides an inventory of water research activities, identifies future needs and priorities, and evaluates federal research programs on the basis of their capacity to respond to changing priorities for water resources research, coordination and management. Recommendations are made on possible approaches to improve the current situation.

17	**Donald M. Tate**	**Alternative Futures of Canadian Water Use, 1981-2011**

This paper presents projections of withdrawal water uses in Canada by provincial region and major river basin up to the year 2011. According to a range of alternative futures, Canadian water withdrawal would be 27 percent to 124 percent higher and consumption would be 0% to 131% higher by the year 2011 (compared to 1981 levels). An alternative approach for water use forecasting is also presented.

18	**Gary Bowden and Marv Anderson**	**Water and Canadian Agriculture: Selected Issues**

This paper reviews selected issues of water use in Canadian agriculture. Implicit in concerns about agricultural needs is the recognition that water is no longer as freely available for use in agriculture. The authors recommend consistent application of federal benefit-cost guidelines to projects in which there is federal participation.

19	**Carolyn T. Miller**	**Risk Management Workshop**

This paper reports the major findings of a workshop on risk management. The specific themes addressed are the environmental context of risk management, the policy options available, a framework for decision making in the public interest and environmental stewardship in the Canadian setting.

20	**James Robinson and Marv Anderson**	**The Role of Demand Management in a Federal Water Policy**

Presents an overview of water demand management, its importance, and how it should be integrated with supply management to reduce waste in domestic, agricultural and industrial uses. It suggests ways in which the federal government can promote demand management by improved coordination among departments, technical assistance, research, public education, tax measures and support of provincial initiative.

21	**Steve Hanke and Michel Fortin**	**The Economics of Municipal Water Supply: Applying the User-Pay Principle**

This paper examines the user-pay principle as it applies to the municipal water industry. It compares Canadian experience with that in other countries and considers the goals of efficiency, equity and conservation as they would apply in a user-pay municipal system which could operate without senior government grants. The option of privatization of municipal water systems is explored.

22	**C.T. Hatfield and G. Smith**	**Instream Resource Values and Protection Needs in Canada**

This paper identifies the water requirements of various instream uses and their values, analyzes current conflicts and considers methodologies for assessing minimum flow requirements. Instream water quantity control has received too little attention compared with regulation of quality.

*The Royal Commission on the Economic Union and Development Prospects for Canada contributed to the funding of this investigation.

**The Science Council of Canada co-sponsored this investigation.

Appendix G
References

All quotations at the beginning of chapters are taken from submissions to the Inquiry

Part I — Water Resources and Policy Development

Chapter 2 — Evolution of Federal Water Policy

1. Gossage, Peter. 1985. "Water in Canadian History: An Overview". *Research Paper No. 11, Inquiry on Federal Water Policy*. Ottawa.
2. Royal Commission on the South Saskatchewan River Project. 1952. *Report of the Royal Commission on the South Saskatchewan River Project*. Ottawa.
3. Canada, Department of Mines. 1942. *Industrial Waters of Canada, Report on Investigations, 1934-40*. Ottawa.
4. Grauer, A.E. Dal. 1959. "The Export of Electricity from Canada". *Essays in Honour of Henry M. Angus*. Edited by R.M. Clark. University of Toronto Press, Toronto.
5. Honourable Walter Dinsdale. 1962. "Historical Perspective and Expectations of the Conference". *Proceedings of Resources for Tomorrow Conference*, Vol. 7. Queen's Printer. Ottawa.
6. External Affairs Canada. 1964. *The Columbia River Treaty and Protocol: A Presentation*. Ottawa.

Part II — Water Resources, Uses and Pressures

Chapter 3 — Canada's Freshwater Resources

1. Hare, F. Kenneth. 1984. "The Impact of Human Activities on Water in Canada". *Research Paper No. 2, Inquiry on Federal Water Policy*. Ottawa.
2. Fisheries and Environment Canada. 1978. *Hydrological Atlas of Canada*. Plate 18. Ottawa.
3. Freeze, A.R. and J.A. Cherry. 1979. *Ground Water*. Prentice Hall. Toronto.
4. Environment Canada. 1985 (forthcoming). "Groundwater Use in Canada, 1981". *Inland Waters Directorate Scientific Report*, by P.J. Hess. Ottawa.
5. Environment Canada. 1985. Unpublished analysis of river basin runoff by R. Kallio, Engineering Division, Inland Waters Directorate. Ottawa.
6. Environment Canada. 1984. "Background Information on Water Quality in Selected Canadian River Basins". Unpublished paper by R.E. Kwiatkowski, Water Quality Branch, Inland Waters Directorate. Ottawa.
7. Canadian National Committee of the International Commission on Large Dams (CANCOLD). 1985. *Register of Dams in Canada*.
8. Quinn, Frank. 1981. "Water Transfers — Canadian Style". *Canadian Water Resources Journal*. V.6, No. 1.

Chapter 4 — Water Demands and Conflicts

1. Tate, Donald M. 1985. "Alternative Forecasts of Canadian Water Use, 1981-2011". *Research Paper No. 17, Inquiry on Federal Water Policy*. Ottawa.
2. Environment Canada. Forthcoming (1985). *Canada Water Year Book, 1985*. Supply and Services Canada. Ottawa.
3. Canada. Department of Industry, Trade and Commerce. Canadian Government Travel Bureau. 1970. *1969 Vacation Trends and Recreational Patterns*. Queen's Printer. Ottawa.
4. Tenant, Donald L. 1976. "Instream Flow Regimes for Fish, Wildlife, Recreation and Related Resources". *Fisheries* No. 1
5. Muller, R. Andrew. 1985. "The Socio-economic Value of Water in Canada". *Research Paper No. 5, Inquiry on Federal Water Policy*. Ottawa.
6. Bruce, James and Henry Hengeveld. 1985. "Our Changing Northern Climate". *GEOS* V.14, No. 1. Energy, Mines and Resources Canada. Ottawa.

Chapter 5 — Pressures on Water Quality

1. Ontario Ministry of the Environment. 1984. *Water Management*. Toronto.
2. Environment Canada. 1983. *Canada Water Year Book 1981-1982*. Supply and Services Canada. Ottawa.
3. Environment Canada, Inland Waters Directorate. 1985. *Background Information on Water Quality in Selected Canadian River Basins*. Unpublished report prepared by R.E. Kwiatkowski, Water Quality Branch. Ottawa.
4. Parliamentary Sub-Committee on Acid Rain. 1981. *Still Waters*. Supply and Services Canada. Ottawa.
5. Environment Canada. 1982. *National Inventory of Municipal Waterworks and Wastewater Systems in Canada 1981*. Supply and Services Canada. Ottawa.
6. International Reference Group on Great Lakes Pollution from Land Use Activities. 1978. *Environmental Management Strategy for the Great Lakes System*. Prepared for the International Joint Commission. Windsor.
7. Hare, Kenneth F. 1984. "The Impact of Human Activities on Water in Canada". *Research Paper No. 2, Inquiry on Federal Water Policy*. Ottawa.
8. MacLaren, J.W. 1985. "Municipal Water and Sewage Works Infrastructures". *Research Paper No. 3, Inquiry on Federal Water Policy*. Ottawa.
9. United States Environmental Protection Agency. 1984. *Ground Water Protection Strategy*. Office of Ground Water Protection. Washington.
10. Vonhof, J.A. 1985. "Groundwater Issues: An Overview". *Research Paper No. 14, Inquiry on Federal Water Policy*. Ottawa.
11. Government of Prince Edward Island, Ministry of Community and Cultural Affairs. 1984. Brief No. 043 to the Inquiry on Federal Water Policy. September 26. Charlottetown.

Part III — The Legal Framework

Chapter 6 — The Constitutional Base

1. *Constitution Acts, 1867 to 1982*, Consolidation as of April 17, 1982, Department of Justice, Ottawa.
2. Rueggeberg, Harriet and Andrew R. Thompson. 1984. "Water Law in Canada". *Research Paper No. 1, Inquiry on Federal Water Policy*. Ottawa.
3. *Interprovincial Co-Operatives Ltd. v. The Queen in the Right of Manitoba*, 1975, 53 D.L.R. (3d) 321 (S.C.C.)

Chapter 7 — The Framework of Federal Water Law

1. Rueggeberg, Harriet and Andrew R. Thompson. 1984. "Water Law in Canada". *Research Paper No. 1, Inquiry on Federal Water Policy*. Ottawa.
2. Fisheries Act, R.S.C. 1970, c. F-14.
3. Department of Fisheries and Oceans. 1985. *Proposed Policy and Procedures for Fish Habitat Management*. Ottawa.
4. Environmental Contaminants Act, R.S.C. 1974-75-76, c. 72.
5. Pest Control Products Act. R.S.C. c. P-10, as amended by S.C. 1980-81-82-83, c. 88, s. 1.
6. Canada Shipping Act, S.C. 1970, c. S-9, amended R.S.C. 1970 (2nd Supp.) c. 27, amended 1971, S.C. 1970-71-72, c. 27.
7. Atomic Energy Control Act, R.S.C. 1970, c. A-19.
8. Navigable Waters Protection Act, R.S.C. 1970, c. N-19.
9. Prairie Farm Rehabilitation Act, R.S.C. 1970, c. P-17.
10. International Boundary Waters Treaty Act, R.S.C., c. I-20.
11. Migratory Birds Convention Act, R.S.C., c. M-12.
12. International River Improvements Act, R.S.C. 1970, c. I-22.
13. Canada Water Act, R.S.C. 1970, (1st Supp.), c. 5.
14. Northern Inland Waters Act, R.S.C. 1970, (1st Supp.) c. 28.
15. Government Organization Act, 1979, S.C. 1978-79, c. 13.

Chapter 8 — International Arrangements

1. Bourne, Charles. 1974. "Canada and the Law of International Drainage Basins", in MacDonald, Morris and Johnson, *Canadian Perspectives on International Law and Organization*. University of Toronto Press. Toronto.
2. LeMarquand, David. 1985. "Boundary Water Relations and Great Lakes Issues". *Research Paper No. 8, Inquiry on Federal Water Policy*. Ottawa.
3. Munton, Donald. 1981. "Paradoxes and Prospects", in Spencer, Kirton and Nossal, *The I.J.C. Seventy Years On*. Centre for International Studies. Toronto.
4. International Joint Commission. 1984. *Second Biennial Report Under the Great Lakes Water Quality Agreement*.

Part IV — Policies and Programs

Chapter 9 — Programs and Resources

1. Treasury Board of Canada. 1985. *1985-86 Estimates, Part III*. Supply and Services Canada. Ottawa.
2. Percy, D.R. 1984. "Federal-Provincial Jurisdiction Issues", in Thompson and Rueggeberg "Water Law in Canada". *Research Paper No. 1, Inquiry on Federal Water Policy*. Ottawa.
3. Thompson, A.R. 1984. "Basic Water Law", in Thompson and Rueggeberg "Water Law in Canada". *Research Paper No. 1, Inquiry on Federal Water Policy*. Ottawa.
4. Environmental Resources Centre. 1984. *Water Management — A Prairie Overview*. Edmonton.
5. Canada West Foundation. 1982. *Nature's Lifeline: Prairie and Northern Waters*. Calgary.
6. Saskatchewan Water Corporation. 1984. Brief No. 197 to the Inquiry on Federal Water Policy. December. Ottawa.
7. Ontario Ministry of Natural Resources. 1984. Brief No. 149 to the Inquiry on Federal Water Policy. October. Toronto.
8. O'Riordan, J. "Strategic Planning and River Basin Management", in *Proceedings of the Second Annual National Resource Conference Water Policy for Western Canada*. 1982. September 9-12. Banff Centre School of Management. Banff.
9. Ontario Ministry of the Environment. 1984. *Water Management: Goals, Policies, Objectives and Implementation Procedures*. May. Toronto.

Chapter 10 — Water Management for the Future

1. Association of Conservation Authorities of Ontario. 1984. Brief No. 250 to the Inquiry on Federal Water Policy. December 13.
2. Institute of Public Administration of Canada. 1985. Pre-prints from 5th International Seminar. "Management of Water Resource". Toronto.
3. Hanke, Steve and M. Fortin. 1985. "The Economics of Municipal Water Supply: Applying the User-Pay Principle". *Research Paper No. 21, Inquiry on Federal Water Policy*. Ottawa.
4. Consumers' Association of Canada, British Columbia Branch. 1984. Brief No. 181 to the Inquiry on Federal Water Policy. November 19. Vancouver.
5. Canadian Federation of Agriculture. 1984. Brief No. 241 to the Inquiry on Federal Water Policy. December 18. Ottawa.
6. Manitoba Department of Natural Resources. 1984. Brief No. 258 to the Inquiry on Federal Water Policy. October. Winnipeg.
7. Canadian Labor Congress. 1984. Brief No. 170 to the Inquiry on Federal Water Policy. December. Ottawa.
8. Organization for Economic Co-operation and Development. 1975. *The Polluter Pays Principle*. Paris.
9. Robinson, James E. and Marv Anderson. 1985. "The Role of Water Demand Management in a Federal Water Policy". *Research Paper No. 20, Inquiry on Federal Water Policy*. Ottawa.
10. Miller, Carolyn. 1985. "Risk Management Workshop". *Research Paper No. 19, Inquiry on Federal Water Policy*. Ottawa.
11. Treasury Board of Canada. 1976. *Benefit-Cost Analysis Guide*. Supply and Services Canada. Ottawa.
12. Drinkwater, K.F. 1984. "Effects of River Runoff on the Marine Environment off Eastern Canada". Brief No. 004 to the Inquiry on Federal Water Policy. September. Dartmouth.
13. Day, J.C. 1985. "Canadian Interbasin Diversions". *Research Paper No. 6, Inquiry on Federal Water Policy*. Ottawa.
14. International Joint Commission. 1985. *Great Lakes Diversions and Consumptive Uses*. A Report to the Governments of the United States and Canada under the 1977 Reference.
15. Environment Canada, Environmental Protection Service. 1982. *National Inventory of Municipal Waterworks and Wastewater Systems in Canada 1981*. Updated to January 1985. Supply and Services Canada. Ottawa.
16. MacLaren, James. 1985. "Municipal Waterworks and Wastewater Systems". *Research Paper No. 3, Inquiry on Federal Water Policy*. Ottawa.
17. Task Force on Municipal Infrastructure of the Federation of Canadian Municipalities. 1984. *Canada's Urban Infrastructure*. Ottawa.
18. Federation of Association on the Canadian Environment (FACE). 1984. Brief No. 188 to the Inquiry on Federal Water Policy. December. Ottawa.
19. American Society of Civil Engineers and American Bar Association. 1951. *Fundamental Consideration in Rates and Rates Structures for Water and Sewage Works*.
20. Freshwater Society. 1985. *Water Management in Transition*. Navarre, Minnesota.
21. Prairie Farm Rehabilitation Administration. 1984. Brief No. 117 to the Inquiry on Federal Water Policy. November.
22. Bowden, Gary and Marv Anderson. 1985. "Water and Canadian Agriculture". *Research Paper No. 18, Inquiry on Federal Water Policy*. Ottawa.
23. Veeman, Terrence S. 1985. "Water and Economic Growth". *Discussion Paper No. 279, Economic Council of Canada*. Ottawa.
24. Environment Canada. Environmental Protection Service. 1984. *Status Report on Abatement of Water Pollution from the Canadian Pulp and Paper Industry (1982)*. Ottawa.
25. Niagara Institute. 1985. *Investment for Competition in Environmental Improvement in the Pulp and Paper Industry*. Niagara-on-the-Lake.
26. Great Lakes United. 1984. Brief No. 204 to the Inquiry on Federal Water Policy. December. Ottawa.
27. Grover, Brian and David Zussman. 1985. "Safeguarding Canadian Drinking Waters". *Research Paper No. 4, Inquiry on Federal Water Policy*. Ottawa.
28. Task Force on Water Quality Guidelines. 1984. Report to the Canadian Council of Resource and Environment Ministers. Toronto.

Chapter 11 — The Search for Knowledge

1. Mitchell, Bruce and Edward McBean. 1985. "Water Resources Research in Canada: Issues and Opportunities". *Research Paper No. 16, Inquiry on Federal Water Policy*. Ottawa.
2. Environment Canada. 1984. "Water Resources Research in Canada in the Late 1970s. *Inland Waters Directorate Technical Workshop Series No. 4* by A.R. Lefeuvre. Ottawa.
3. Bruce, J.P. and D.E.L. Maasland. 1968. "Water Resources Research in Canada". *Science Council Secretariat, Special Study No. 5*. Ottawa.
4. Australian Water Resources Council, Working Group on Water Research Policy. 1982. *Water Research in Australia: New Directions*. Canberra.
5. *Toronto Globe and Mail*. 1985. "Research Funds Won't Double as PCs Promised in Campaign". Page 3. May 15.
6. Sato, Ryuzo and Gilbert S. Suzawa. 1983. *Research Productivity: Endogenous Technical Change*. Auburn House, Boston.
7. Environment Canada. 1985. *Water Quantity Surveys Federal-Provincial Cost-Sharing Agreements Annual Report 1983-84*. Ottawa.

Chapter 12 — Water Export

1. Beach, Colin A. 1984. "Coast Mountain Aquasource Ltd. Proposal." Brief No. 183 to the Inquiry on Federal Water Policy. November 22. Vancouver.
2. *Maclean's*. 1985. "A Water Deal Dries Up". June 17. Toronto.
3. Blakey, Lewis H. 1984. "Interbasin Transfers of Water: Problems and Politics". *Military Engineer*. V. 76, No. 492.
4. Scott, Anthony. 1985. "The Economics of Water Export Policy". *Research Paper No. 7, Inquiry on Federal Water Policy*.
5. Kierans, Thomas W. 1984. "The Great Recycling and Northern Development (GRAND) Canal." Brief No. 003 to the Inquiry on Federal Water Policy. September 24. St. John's.
6. High Plains Associates. 1982. *Six-State High Plains - Ogallala Aquifer Regional Resources Study*. Report to the U.S. Department of Commerce and the High Plains Council. Austin, Texas.
7. U.S. Water Resources Council. 1978. *The Nation's Water Resources, 1975-2000*. Second National Water Assessment. Washington.
8. De Cooke, B.G., J.W. Bulkley and S.J. Wright. 1984. "Great Lakes Diversions: Preliminary Assessment of Economic Impacts." *Canadian Water Resources Journal*. V.9, N.1.
9. Kneese, Allen W. 1984. "High Plains, Low Water". *Resources*. No. 78 (newsletter). Resources for the Future, Washington.
10. Arizona. Department of Water Resources. 1984. *Management Plan, First Management Period 1980-1990*. Phoenix.
11. LeMarquand, David. 1984. "Water Export from Canada By Tanker." Unpublished paper prepared for Inland Waters Directorate, Environment Canada. Ottawa.
12. Alberta Environment. 1979. *Water Resource Management Principles for Alberta*. Edmonton.
13. Great Lakes Governors Task Force. 1985. *Water Diversions and Great Lakes Institutions*. Appendix III.
14. Bourassa, Robert. 1985. *Power from the North*. Prentice Hall, Canada. Scarborough. Chapter 9
15. Bocking, Richard C. 1985. "Canadian Water: A Commodity for Export?" Brief No. 307 to the Inquiry on Federal Water Policy. March 1985.
16. International Joint Commission. 1985. *Great Lakes Diversions and Consumptive Uses*. A report to the governments of Canada and United States under the 1977 reference.

Part V — Water Management In Northern Canada

Chapter 13 — Water Management in the Territories

1. Mackenzie River Basin Committee. 1981. *Mackenzie River Basin Study Report*.
2. Yukon River Basin Committee. Forthcoming 1985. Report on the Yukon River Basin Study. Report to the governments of Canada, British Columbia and Yukon.
3. Northern Inland Waters Act. R.S.C. 1970, 1st Supp. c. 28.
4. Thompson, A.R. and H. Rueggeberg. 1984. "Water Management in the Yukon Territory, Integration with Land Use Planning". *Socioeconomic Project Report No. 5A, Yukon River Basin Study*. Westwater Research Centre, University of British Columbia. Whitehorse.
5. Government of Northwest Territories, Department of Renewable Resources. 1984. Brief No. 053 to the Inquiry on Federal Water Policy. October 16. Yellowknife.
6. Canadian Arctic Resources Committee. 1984. Brief No. 207 to the Inquiry on Federal Water Policy. December 4. Ottawa.
7. Christiensen, Ione, I.J. Cable K. Weagle and David Anderson. 1983. "Resources Regulations and Realities". *Report of the Yukon Placer Mining Guidelines Public Review Committee* for the Minister of Indian Affairs and Northern Development. Ottawa.
8. Dene Nation vs. The Queen. 1984. February 14.
9. Rueggeberg, Harriet. 1985. "Northern Water Issues". *Research Paper No. 12, Inquiry on Federal Water Policy*.
10. Yukon Conservation Society vs. Yukon Territory Water Board. 11 CELR 99, Fed. Ct.
11. Northwest Territories Water Board. 1984. Brief No. 096 to the Inquiry on Federal Water Policy. October 16. Yellowknife.
12. Queenstake Resources Ltd. 1984. Brief No. 021 to the Inquiry on Federal Water Policy. October 15. Whitehorse.
13. Northern Canada Power Commission. 1984. Brief No. 092 to the Inquiry on Federal Water Policy. October 15. Whitehorse.
14. Department of Indian Affairs and Northern Development. 1984. Brief No. 228 to the Inquiry on Federal Water Policy. December 19. Ottawa.
15. Dene Nation. 1984. Brief No. 093 to the Inquiry on Federal Water Policy. October 16. Yellowknife.
16. Tungavik Federation of Nunavut, Land Claims Project. 1984. Brief No. 165 to the Inquiry on Federal Water Policy. November 5.
17. Berger, Justice Thomas R. 1977. *Northern Frontier, Northern Homeland*. Report of the Mackenzie Valley Pipeline Inquiry, Vol. 1, to the Minister of Indian Affairs and Northern Development. Ottawa.

Part VI — Structures and Relationships

Chapter 14 — Administrative Organization and Coordination

1. Mactavish, John S. 1985. "The Federal Role in Water Management". *Research paper No. 15, the Inquiry on Federal Water Policy*. Ottawa.
2. Sauvé, N. 1985. Unpublished data. Finance, Personnel and Administration Services. Environment Canada. Ottawa.
3. Natural Sciences and Engineering Research Council of Canada. 1985. *Research Talent in the Natural Sciences and Engineering — Supply and Demand Projections to 1990*. Ottawa.

Chapter 16 — Channelling Public Participation and Advice

1. Schwass, R.D. 1985. "Public Information and Participation in Water Resource Policy". *Research Paper No. 10, Inquiry on Federal Water Policy*. March. Ottawa.
2. Marean, John H. 1984. Brief No. 049 to the Inquiry on Federal Water Policy. October 10. Calgary.
3. Environment Canada. 1981. *Policy for Public Consultation and Information Availability*. Ottawa.
4. Canadian Environmental Advisory Council. 1985. *Review of Activities 1981-82, 1982-83*. Ottawa.

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For Further Information

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